SCHOOL SCIENCE AND MATHEMATICS

VOL. XII, NO. 3 CHICAGO, MARCH, 1912 WHOLE NO. 95

APPLICATION OF ZOOLOGY TO THE LIFE OF THE PUPIL AND OF THE COMMUNITY.

BY W. WHITNEY,
Bowen High School, Chicago.

The first attempts to teach zoölogy in the high school through the laboratory as a foundation were made but comparatively few years ago, well within the memory and experience of the older teachers now present. There were no suitable text-books, and the laboratory course was modeled upon the well-known Huxley and Martin course; the exhaustive study of types. This course had its value as a disciplinary course, but it did not appeal to the experience of the pupil and certainly did not appeal to the enthusiasm of the pupil. The course was simply a modified college course, and even the laboratory tables and other equipment of the laboratory were copied direct from the college laboratory.

Almost from the first many of the teachers of zoölogy saw that such a course was not suited to the needs of the high school pupil and began slowly to lop off from the type studies and add more variety to the course, but the change has worked out very slowly and probably a large majority of teachers of zoölogy at the present time use a modified type course arranged in evolutionary order, or with insects used as an introduction.

Of late some teachers and some authors of text-books are cutting away from the type plan and evolutionary order and are arranging the work by topics or problems. But probably the most potent force at work now to alter the point of view of teachers of zoölogy is the rapid introduction of courses in agriculture into the curricula of high schools. The question before us to-day is really as to whether agriculture may not altogether supplant zoölogy and botany—especially in the smaller cities and towns. There is insistent demand, and I believe it is right, that our courses be made more practical and more within the experiences, present and future, of our pupils. Many schools are solving this by putting in agriculture in place of biology.

[1]Read before the biology section of the Central Association of Science and Mathematics Teachers, in Chicago, Dec. 1, 1911.

Can the course in zoölogy be made more practical and be made to appeal to both pupil and community as something worth while and at the same time retain its value as a training in scientific habit? I believe the subject of zoölogy is well qualified to fill such a role.

We shall inquire first as to the points of contact between man and the animals, more especially as to those which may come within the experience of a school community and of the pupils, or may have influence upon them. These points of contact and influence are more extensive and influential than one would, at first thought, suppose. Beginning with the higher animals, there are first of all the domesticated animals, including the pets of the family—the horse, cow, cat, dog, poultry, etc. The wild animals that furnish fur should be mentioned. Then there is a large group of both wild and domesticated animals that furnish food in one way or another for the table. The birds form a very important group with which all come in contact—even if they do not realize their usefulness. Reptiles and amphibians have interest because of their usefulness in keeping down insect pests. The fishes are always interesting to all.

But the insects, as destroyers of vegetation—field crops, trees, gardens, and house plants—carriers of disease, pests in the household, as well as by their usefulness in certain ways, furnish the surest means of connecting zoölogy with the interest of both community and pupils. Even the lowly earthworm can be made to contribute a share of interest.

It is not necessary, however, for me to enumerate all the points of contact, for they are well known to all teachers of zoölogy. The real question is as to how to present or teach the subject in such a way that the pupils and the community shall really be reached and their interest aroused to a point where it shall be a permanent possession. My first suggestion is that the study of animals as types be abandoned. Instead, study the animals that will teach something and always let the pupils discover why that particular animal is important, what facts it illustrates. By far the best animals to begin with are the insects, for they are within the experience of everyone. Don't take insects unknown to the pupils, at least at the first, when there are the flies, mosquitoes, bees, butterflies, and many others known to all. If the teacher is alive to his opportunity the pupils will carry home to their parents and friends many tales of the insects, which are bound to stir up interest because of the contact of the insects in one way or another with the lives of these people.

There are certain animals which are comparatively unimportant when studied incidentally, merely because they belong to some group under consideration. But bring these animals together to illustrate some topic and their value and interest are increased many fold. Parasitism is a topic of this sort. Instead of referring to it incidentally in passing several groups why not defer the study of these animals until the right stage is reached, then bring together into one study as many examples of parasitism and degeneration as practicable? The lesson is bound to be much more impressive when reënforced by a number of examples.

Other topics that may profitably be taught in this way are degeneration, influence of habitat, development, adaptation, and many others. In fact, it would be comparatively easy to reduce the entire study of zoölogy to a series of carefully-graded topics using studies of animals as illustration, but I am not prepared to say at the present time that it is best to carry the topic method to this conclusion.

Another method for increasing interest and the practical aspect of zoölogy is the proper use of an outdoor laboratory. This is a comparatively new idea but one that is bound to come into use. By an outdoor I mean a plot of land near the school building, not necessarily very large, given over to the departments of zoölogy and botany. There should be an allowance made by the school board to pay for the heavy manual labor and for tools and fertilizers as needed. The plot should be fenced and there should be in it a small pond or pool. In this plot there should be planted trees, shrubs, and perennials native to the neighborhood. There would be beds for experimental work by classes in botany. Incidentally, there would be many animals attacking the plants which it would be the business of the zoölogy classes to study and exterminate. The plot should be near enough to the school so that classes could take their regular period of work in this outdoor laboratory whenever desired. Very practical work on animals could be done here that could not be done with artificial conditions in the indoor laboratory. After this plot was once started its cost for upkeep would not be great, and the money will be cheerfully voted when once its great use and purpose is understood by school boards.

Another thing indispensable for an up-to-date laboratory is the library. I refer to a reference library for the pupils, not for the teacher. In this library there should be collected books on natural history and some on travels, also elementary text-books co-

ordinate with the one used as the adopted text-book. There should be nontechnical books for identifying animals such as the pupils may bring in from the field or home. Such a library need not cost over $200 at the start and should be added to from time. The teacher should contrive natural uses for the library, one of the best being to assign interesting topics for short papers in concluding a topic under study in the laboratory.

One of the very best studies for gaining the real interest of pupils, an interest that will be communicated to the parents as well, is the field study of birds. When once the interest in birds is awakened it becomes a permanent possession that is seldom wholly lost in later years. The good done by such a study is beyond calculation. Every school should organize a junior Audubon Association and spread the knowledge of the work of this society.

Aside from the enthusiasm of the teacher himself probably the most efficient aid in stimulating enthusiasm in the class is to have a great abundance of living animals in the laboratory. It does not pay to be stingy or lazy in providing such material. Pupils like to see them and watch their movements, and they like lots of specimens when studying an animal. Instead of making one weary set of crayfishes, for example, do service for several successive classes, why not have a fresh lot for each class? They do not cost much, and it will make the study very much more attractive and give better results. The same thing applies to all studies of animals in the laboratory. It is surely wicked to have the same poor earth worm or frog or any other animal handled again and again by successive classes until it ceases to react and perhaps gives up even its life. An abundance of material would avoid this and have a much better effect upon the class to say nothing of the quality of the results obtained.

There should also be many animals kept in the laboratory simply because they are attractive and the pupils like them. Such are fish, mice, canaries or chickens, snails, honey bees, ants, and in season many others.

The study of the higher vertebrates has always proved more interesting to my pupils than those of lower types of life, and I believe this is generally true in other schools, but we go on year after year consuming the greater portion of the year with studies of invertebrates and find so little time at our disposal when the vertebrates are reached that the mammals are scarcely touched. It is true that these studies cannot be so easily managed by our

present laboratory methods. We cannot go out and gather up squirrels and rabbits as we can grasshoppers. There is no doubt, though, that studies of mammals could be accomplished in a satisfactory manner and that they would yield better results with our pupils than many of the invertebrate studies.

In all studies from the beginning to the end of the course the relation of animals and man should be brought out in various ways. Sometimes this is a direct relationship, sometimes only indirect but it will always add interest to the studies.

I have left to the last the discussion of the influence of a series of such studies as I have outlined upon the moral character of the pupils and through them upon the community. There is no other subject in the curriculum that can have so great an influence, not even botany, which, however, may exert greater influence in certain other directions which are important to the community. There are several ways in which this influence is exerted. The most important of these is the fact that pupils in zoölogy cannot be blind to the truth that the laws and reactions upon the lives of animals they are studying must also apply to their own lives. Consider such studies as these—community life of various animals and the effect of this mode of life upon the individual; the effect of mode of life upon structure; the influence of habitat; the degeneration due to sedentary life and the nonuse of organs or parts of the body; the effects of parasitism. It would be a dull pupil indeed who could not see the bearing of these laws upon his own life and the lives of others. These animals he is studying are living things the same as he, and the effect follows cause with unfailing regularity, too unfailing to be misunderstood. If studies are carried to mammals the pupil comes closer to himself and discovers again the same laws governing.

In zoölogy the subjects of reproduction, the sexes, and development are studied as a matter of course, fully and frankly without danger of embarrassment and the scientific meaning of these subjects is learned in a way that will best influence the pupil. The law of inheritance and the doctrine of evolution become clear, at least, as to their general bearing. If the pupil gained nothing else in the entire year's work than an understanding of these subjects it would be time well spent.

If zoölogy is taught in the right manner the pupil learns the value of accuracy, truthfulness. That scientific conclusions are not based upon guesses or imperfect observations. He should

gain some idea, at least, of what science and the scientific method mean, and that in this method there can be no shams or falsehood.

In conclusion I wish to sum up the points I have endeavored to make clear. The pupil learns much about the lives of animals in his surroundings. He learns the good that some do, and learns to treat these with respect because of this. He learns to love certain animals, to watch their comings and goings and their intimate life. He learns of dangers from other animals and how he may protect himself and his friends from these dangers. He learns of the harm that still others do and how they may be successfully combated. He learns to know himself and certain vital laws that govern him. He learns to respect the truth and to consider it as fundamental to right thinking. He learns that effect follows cause with unfailing certainty. He may even learn very much that he is not aware of at the time, but when the right time comes it comes back to him to guide him to the right decision.

But among all the good things zoölogy has done for my pupils, there is one thing I have not mentioned that has pleased me most of all. The enthusiasm and liking for the study have been the means of putting new ambition and determination into a good many boys to stick to their school work and redeem wasted opportunities. A fine enthusiasm will do wonders for a boy, even though every other influence is against him, and it is cases of this sort that I have watched that have given me much courage and a whole-souled belief in my subject.

JUDICIAL WISDOM.

Indiana has a good pure food law and, more important still, it has efficient and active officers to enforce it. One of the valuable provisions of the Indiana act was designed to protect the public from the sale of impure milk. The newspapers have recently chronicled the fact that an Indiana dairyman was found by the state inspectors to be selling dirty milk. The officers purchased some of this milk for the purpose of securing evidence against the dairyman. They found the dirt and the dairyman was prosecuted for selling a filthy product. When the case came into court, the attorneys for the milk dealer maintained that their client was not guilty of violating the law because it must be shown that the milk was purchased for human food, when, as a matter of fact, it was purchased in this instance for purposes of analysis. The judge before whom the case came sustained the motion of the defendant's attorneys and held that the dairyman was not guilty of an offense under the Indiana Food and Drugs Act! The *Journal of the American Medical Association* reports this decision in a recent issue and says that it refrains from commenting on this example of judicial wisdom for fear of violating the postal laws.

THE ELECTRIC FURNACE FOR STEEL.[1]

By L. A. Touzalin,
Asst. Chief Chemist, Illinois Steel Company, South Works.

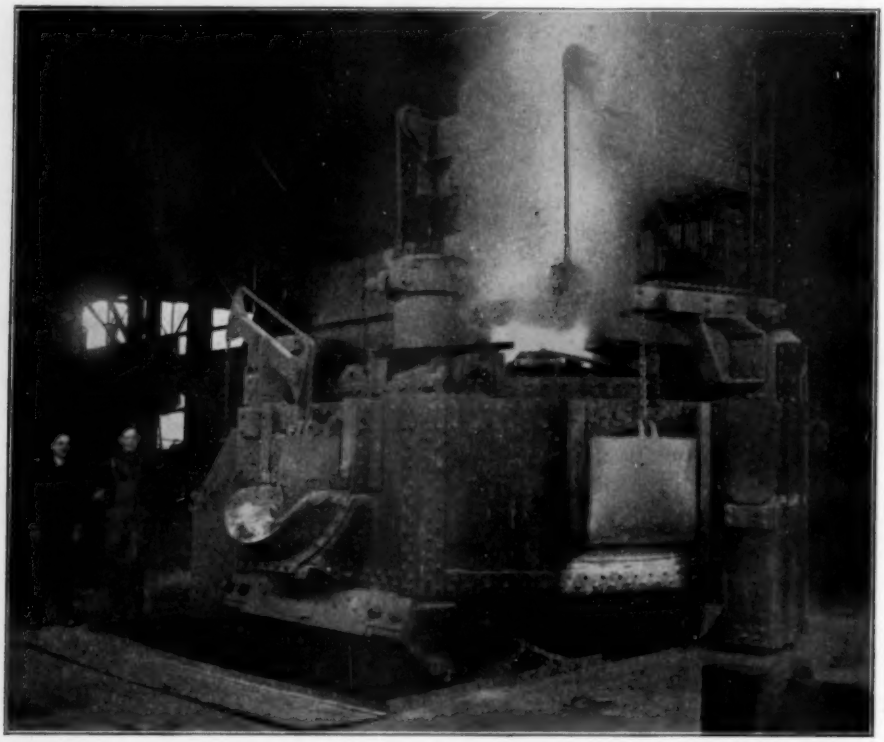
In February of 1909 the Steel Corporation decided to erect two Heroult furnaces for refining steel, each of 15 tons capacity. One was built at South Works of the Illinois Steel Company, and the other at the Worcester, Mass., plant of the American Steel and Wire Company. At South Chicago the electric furnace is used for refining molten metal from the Bessemer converter, at Worcester for refining molten metal from the basic open hearth. The object of the combination of the ordinary acid Bessemer converter and the electric furnace is to produce steel of open hearth quality or better. The object of the combination of basic open hearth and electric furnace is to produce steel better than the best acid open hearth steel in quality. Before these installations the largest Heroult furnace ever built had a capacity of 5 to 8 tons. Hitherto it had been used essentially as a substitute for the crucible steel process for the manufacture of high-grade tool and special steels. At South Chicago it entered a much wider field of usefulness for it is used for large tonnage products—such as rails, axles, billets, and castings. The South Chicago plant process is perhaps the more interesting of the two mentioned before since it includes the more involved metallurgical process of both dephosphorization and desulphurization of the steel in the electric furnace, while the metal charged from the basic open hearth into the electric furnace at Worcester is already dephosphorized. Metallurgists believe that if the electric furnace in combination with the Bessemer converter can make as good or better steel than the open hearth alone, it will mean a new lease of life to the converter.

The furnace proper is essentially built like the body of an open hearth furnace except that the outside horizontal cross-section plan is approximately that of a circle of 13½ feet in diameter, with two flattened portions, situated at the front and back, respectively. The furnace rests on a floating pinion which enables it to be tilted to an angle of approximately 29° by means of an hydraulic cylinder attachment. The shell of the furnace is of steel plate one inch thick. The bottom and walls are of magne-

[1]The data given in this paper was taken from an illustrated lecture delivered before the Chicago Section of the American Electrochemical Society, Jan. 20, 1911, by C. G. Osborne.

Read before the joint meeting of the physics and chemistry sections of the Central Association of Science and Mathematics Teachers, Dec. 1, 1911.

site brick and the roof of silica brick, 12 inches in thickness. There are 5 doors, two on each side of the furnace and one in front over the pouring spout. They work in the usual groove arrangement and are operated by steam pressure. The front door is an exception to this, being operated by hand with a counterbalance. The heat is supplied from electrodes through the top. There are three of these in the South Chicago furnace, since the current used is 3 phase, in the form of an equilateral triangle each side of which is 5 feet 2 inches in length. The apex of the triangle



THE ELECTRIC FURNACE IN ACTION.

points towards the back of the furnace. There are separate holders for each electrode, which are designed to carry 24 inch electrodes but which may be adjusted, by contact blocks, to hold electrodes of smaller size. The weight of each electrode is supported by chains which run back over pulleys to the drums at the back of the furnace. Motors, attached by gears to the individual drums, regulate the electrodes. Such regulation is by hand, by controllers, or by an automatic device. The automatic device is

quite complicated and I will not be able to explain it in detail other than to simply state that a magnet coil, floating magnet coil, and current transformers are used for each individual electrode.

The power for the furnace is generated by dynamos having as prime movers, reciprocating gas engines, reciprocating steam engines, high pressure and low pressure turbines. It is 3 phase, 2,200 volts, and 25 cycle. At the electric furnace it is stepped down by means of three 750 k. w. transformers to the voltage of the furnace, which is ordinarily about 90 volts. The wattage is usually about 500 to 650 k. w. h. per leg.

THE OPERATION OF THE FURNACE.

The normal operation of the furnace is as follows:

Ordinary Bessemer pig iron is full blown in a 15-ton Bessemer converter, in from eight to twelve minutes. It is then poured directly from the Bessemer vessel to an electric furnace transfer ladle and drawn to the electric furnace building, a distance of about ¼ mile, in about five minutes. As a precaution against the possible formation of a skull in the ladle, the Bessemer charge is blown about 1,500 pounds of scrap "hotter" than ordinary Bessemer practice.

Immediately the ladle is received at the electric furnace it is picked up by the crane, slightly tilted, and the silicious slag is completely cleaned off by hand-rabbling. The metal is now ready for charging. To do this, the ladle is merely turned over on its trunnions and the metal poured into a spout, through which it rushes to the furnace. This operation of cleaning off the slag and charging occupies from five to ten minutes.

The electrodes are lowered and the current turned on.

As the metal is being poured into the furnace, the helpers shovel iron oxide and lime into the furnace through the working doors.

In this way a basic oxidizing slag is produced which serves to remove the phosphorus. In about thirty minutes this slag has served its purpose, and the furnace is tilted slightly forward and the slag removed in from five to ten minutes by hand-rabbling.

The recarburizer is added at this point. On the bare surface of the oxidized metal, lime is quickly added, with sufficient fluor spar to keep the mass fluid. In about fifteen minutes this lime is melted, and finely divided coke dust is now thrown onto the top of the slag beneath each of the three electrodes.

Under the influence of the arc, calcium carbide is produced in gradually increasing quantities.

As soon as this state of affairs is reached, a neutral if not an actually reducing atmosphere has been obtained. From here to the finish there is practically a dead-melt in a reducing atmosphere. The slag at this stage of the process is fluid and highly basic. If a sample should be taken and water added to it, the resultant acetylene gas, from the well-known calcium carbide and water reaction, is of sufficient quantity to light and burn for half a minute.

Tests are now taken to show the condition of the steel. A small cylindrical test piece is poured and forged to a round pancake-shaped object under a steam hammer located at the furnace. If this forged sample shows by its appearance a satisfactory condition of the metal, the bath is tapped. If not, further refining is necessary.

To tap the furnace, the electrodes are raised from the bath and the ladle swung by a crane under the pouring spout and the tilting lever pulled forward.

The pouring is done through a 1½-inch nozzle to molds of varying sizes.

A typical furnace charge sheet is as follows:

ELECTRIC FURNACE CHARGE SHEET.

Material.

	Lb.	Kg.
Bessemer blown metal	30,000	13,635
Scale	700	317
Ferro-Manganese, 80%	200	91
Ferro-Silicon, 10%	60	27
Ferro-Silicon, 50%	80	36
Recarbonizer	130	59
Fluor Spar	400	182
Coke Dust	200	91
Lime—1st Slag	600	273
Lime—2d Slag	600	273
Dolomite	400	182
Magnesite	25	11

Tapped previous heat	7:00 A. M.
Metal Ordered for	7:15 "
Metal Received	7:15 "
Began Fettling	7:17 "
Current on	7:27 "
Slag Off—Began	8:00 "

Slag Off—Finished .....8:11 "
Tapped .....8:48 "
Time of Heat .....1 Hr. 21 Min.

It will be seen from this that it takes us an hour and a half to two hours to a heat, according to the grade of steel produced.

What is actually done in the electric furnace at South Works is to take oxidized blown metal of an approximate analysis of

C	*S*	*P*	*Mn*	*Si*
0.05-0.10	0.035-0.070	0.095	0.05-0.10	0.005-0.015

and produce deoxidized steel low in sulphur and phosphorus and, within reasonable limits, of practically any analysis required by the consumer.

THE VARIETY OF PRODUCT.

The electric furnace at South Chicago has operated on a greater variety of product than any furnace in the world, and with bewildering intermingling of high-grade alloy steels, high-grade carbon steels and ordinary carbon steel. Ordinary carbon steel rails of a dozen different sections, billets of all sizes and grades, plates of all sizes and grades, structural shapes, castings, small and large, high carbon and low, and forgings of all sizes; nickel, nickel-chrome, chrome, manganese, and silicon steels have been made.

A number of heats from cold materials have also been made. In several of these the worst scrap we could pick up—was taken—stove-plate scrap. With this stock, an axle heat was made which showed excellent physical tests: 77 blows from a 1,640-pound hammer falling 43 feet broke the first axle, and 68 similar blows the second.

COAL EXPORTS IN 1910.

The exports of coal from the United States during 1910, according to the United States Geological Survey, were 13,805,866 long tons, valued at $41,470,792. Of this quantity 3,021,627 long tons, valued at $14,785,387, was anthracite, and 10,784,239 long tons, valued at $26,685,405, was bituminous coal.

The imports of anthracite amounted in 1910 to only 8,195 long tons, valued at $42,244, and those of bituminous coal to 1,497,709 long tons, valued at $3,975,561.

MOLECULES.

By Benj. H. Brown,
Whitman College.

As early as the year 400 B. C. there were philosophers who were beginning to hold that ordinary matter as wood, stone, metal, water, etc., was made up of individual particles too small to be distinguishable by the eye. This view of the structure of matter, however, was of little importance in the ancient thought because it was not based upon any definite observations which could give it a practical application. For more than a thousand years the molecule did not enter into the practical thought of the physical world. In the century just past, however, the idea of the molecule as the smallest piece of a substance came into general use in the working theories of physics, chemistry, and biology. During the very latest years, the molecule has been found to be a veritable treasure-house from which mystery after mystery has been brought forth by experimentation with electric charges and radioactive substances. With the coming of the idea of the electron and the possibility of its further divisibility, the possibility of physical structures breaks anew upon the thought of the twentieth century and is destined to work many and important changes in the accepted theories of matter and the universe. The molecule, then, has an interest not only for its own sake but because of its importance in the thought of the future.

The Shape of Molecules.

When molecules of a gas are heated in a vessel whose volume remains constant, it requires a certain amount of heat energy to warm a gram of the gas one degree centigrade, and this amount of heat is known as the specific heat at constant volume. The applied heat goes to make the molecules move faster, and in some cases to make them rotate, and in other cases to force them into other motions not thoroughly understood. This condition of things may be represented by the equation

$$Hv = Et + Ei$$

which means that the heat supplied at constant volume equals the energy appropriated by the translational motions (Et) plus the energy absorbed by the internal motions (Ei).

When a gas is heated in a vessel whose volume changes so as to keep the pressure constant, the heat required to warm one gram of the gas one degree is greater than that required when the gas remains at constant volume. The heat supplied when the volume

changes not only must warm the molecules, as in the first case, but also must provide the extra energy required to change the volume of the containing vessel against the external pressure. This condition of things may be represented by the equation

$$Hp = Et + Ei + Ee$$

which means that the heat energy supplied at constant pressure and changing volume equals the increase of translational energy (Et) plus the increase of internal energy (Ei) plus the external work (Ee) used in increasing the volume of the vessel by moving a piston cover.

It will be noticed that the heat at constant volume is less than that at constant pressure by the amount required to move the cover of the vessel. Now, it happens that the ratio, $\frac{Hp}{Hv}$, of these two specific heats may be measured more easily than either of them alone, by measuring the velocity of sound in the gas. Hence it is convenient to put the two equations together in the following form

$$\frac{Hp}{Hv} = \frac{Et + Ei + Ee}{Et + Ei}$$

The numerical value of the ratio $\left(\frac{Hp}{Hv}\right)$ is given for several substances in the following table:

Argon	1.66
Helium	1.64
Mercury	1.66
Hydrogen	1.396
Nitrogen	1.405
Oxygen (O_2)	1.40
Hydro-chloric acid (HCl)	1.398
Carbon Monoxide (CO)	1.403
Water (H_2O)	1.287
Hydrogen sulphide (H_2S)	1.28
Carbon dioxide (CO_2)	1.28
Chlorine	1.32
Iodine	1.29
Bromine	1.29
Ammonia (NH_3)	1.317
Chloroform ($CHCl_3$)	1.154
Ether ($C_4H_{10}O$)	1.07

It should be noted that in general the more complicated molecules have a lower ratio of specific heats.

The quantities Et and Ee are easily calculated. There is left then only one unknown quantity in our formula, and this one, Ei, is going to be the one, if there be one, which may be made to throw some light upon the problem of the shape of the molecule.

The term Ee for one degree may be calculated as follows. Suppose that one gram of the gas is confined in a long tube, whose cross-section is one square centimeter, and under a pressure of p dynes per square centimeter. Then the volume of the gas will be V cubic centimeters and it will fill the tube for a length of V centimeters. Now, as the gas is heated one degree, its volume will increase $\frac{1}{T}$ of itself, where T is the value of the temperature measured from absolute zero. The gas in the tube will push the piston cover which confines it, therefore, a distance of $\frac{V}{T}$ centimeters against a pressure of p dynes. The work done will be, therefore, force times distance or p times $\frac{V}{T}$, or $\frac{pV}{T}$ ergs. This then is the value of Ee.

To find Et take a box one centimeter on a side filled with gas at a pressure p dynes per square centimeter, containing n molecules, each of mass m, moving on an average normally to the sides of the box with velocity v centimeters per second. While the molecules of the gas will, of course, be moving in all possible directions within the little box, the components of these motions perpendicular to the sides of the box will be properly measured if we assume that ⅓ of the molecules are in motion with respect to each of the three mutually paired sides of the box. Each molecule, on the average, must pass through a distance of two centimeters, forth and back through the width of the box, or the equivalent of this through the striking of neighbor molecules, for each impact upon the sides of the box. Hence each molecule, on the average, will strike a side of the box $v/2$ times per second. The total number of impacts upon any one face of the cube will be ⅓ of n times $v/2$, or $\frac{vn}{6}$. At each impact with a side of the box a molecule will on the average suffer a change of momentum equal to mv whenever it is stopped by the side of the box and another mv when it is made to rebound from the side with a velocity v, or, in all, the change in momentum for every impact will be on the average $2mv$. Since there are $vn/6$ impacts per second in the gas, and there is a change of $2mv$ units of momentum for each impact, then there must be

a total change of momentum of $2mv$ times $vn/6$, or $\frac{mnv^2}{3}$ per second. This continuous change of momentum through the constant bombardment of the molecules is the cause of the pressure of the gas which must equal the external pressure p. Therefore numerically $\frac{mnv^2}{3} \cdot = p$. Multiplying both sides of this last equation by $3V/2T$ we have

$$\frac{3pV}{2T} = \frac{mnVv^2}{2T}.$$

Since $\frac{mnVv^2}{2T}$ is the translational kinetic energy required to warm one gram of the gas one degree at a temperature T, $\frac{3pV}{2T} = Et$. We have now found Ee and Et, and these values substituted in the equation for the ratio of the specific heats gives

$$\frac{Hp}{Hv} = \frac{\frac{3pV}{2T} + \frac{pV}{T} + Ei}{\frac{3pV}{2T} + Ei}$$

The value of Ei is still undetermined, and no easy and perfect method has been discovered by which it may be measured directly as we did the others It is convenient to proceed on an assumption, and in the first place, suppose that Ei equals zero in a particular case. This is to infer that the molecules in this case when heated do not receive any energy except that used in motions of pure translation and that necessary to push up the cover of the containing vessel. This supposition implies further that the molecules in their numerous accidental collisions with one another from every side and at every angle do not by these simple impacts cause any rotatory motion among themselves. These molecules, therefore, for which Ei equals zero, act as if they were round and smooth and incapable of undergoing distortion through collision with other like molecules for only such bodies can receive impacts always radially, so as to leave no possibility of the action of moments due to the colliding masses. On the supposition, then, that Ei equals zero, the case in which there are no internal motions of rotation or vibrations set up by the mutual collisions of the molecules, the ratio equation becomes

$$\frac{Hp}{Hv} = \frac{\frac{3pV}{2T} + \frac{pV}{T}}{\frac{3pV}{2T}}$$

which gives for the value of $\frac{Hp}{Hv}$, 5/3, or 1.666. By reference to

the table it may be seen that helium, argon, and mercury have very nearly this value for the ratio of their specific heats. If the reasoning above is adequate to the problem, the inference is very plain that the molecules of these substances are round and smooth and practically distortionless when subjected to the ordinary forces of molecular collisions. The chemists also describe these elements as being monatomic, each molecule consisting of only a single atom, and in so far as the chemical evidence applies to the shape of the molecule, it is in perfect agreement with the result obtained above.

In order to proceed further with the investigation it is necessary to make further assumptions. It will be necessary to keep the assumptions in mind, for since they are but the temporary scaffolding for the projection of work into otherwise inaccessible regions, they may not properly be incorporated into the argument itself until they have been verified in some way. But an assumption may be a powerful mental tool when used with caution and estimated at its real value.

Suppose that a multitude of small bodies are in motion in a closed vessel, and colliding with one another in every conceivable manner, then it is postulated that, after the lapse of a sufficient time during which the molecules and their motions may become fairly distributed within the vessel, the kinetic energy of the whole mass of the bodies will be equally apportioned among the degrees of freedom of the colliding bodies. A degree of freedom as used here may be defined as any particular way in which a body may move, as a to and fro motion in any straight line, a rotatory motion in any one plane, or a vibratory motion in a plane. Any one of these motions is a degree of freedom, and bodies may possess several degrees of freedom at the same time.

Continuing now our examination of the ratio equation, let Ei represent one degree of freedom, instead of being no degree of freedom as in the former case. We found above that the translation energy Et equals $3pV/2T$, and since the translational movements could take place in three mutually perpendicular directions corresponding to the three perpendicular sides of the containing box, the energy of a single degree of freedom would be $\frac{1}{3}$ of $3pV/2T$, or $pV/2T$. This value, $\frac{pV}{2T}$, then, is the measure of energy absorbed in one degree of freedom. According to our postulate above, this amount measuring one degree of translation freedom is also equal to the energy used in rotational free-

dom. Putting this value $\left(\frac{p\,V}{2\,T}\right)$ for E*i* into the ratio formula, we have the ratio $\frac{H\rho}{Hv}$ equal to 1.50, after making the obvious reductions. From the table it is seen that there are no substances quoted whose values for the ratio of their specific heats are anywhere near 1.50, and there are no substances known which would give values near this amount. Taking the simplest view of this case, we may provisionally assume that there are no molecules among known substances that have four and only four degrees of freedom. This means that if a molecule has three degrees of translational freedom, it cannot take on one more degree of rotation without at the same time taking on another degree of rotational freedom. If the molecule rotates at all through the action of accidental collisions, it must be able to rotate in more than a single plane. Proceeding further, let E*i* represent two degrees of freedom. Then our ratio equation gives a value of 1.40 for the ratio of the specific heats. From the table we find several substances with values near this number. These molecules, therefore, act as if they had two degrees of freedom in addition to their three degrees of translational freedom common to all gases inclosed in an ordinary vessel. In all these gases, it should be observed that the molecules are diatomic, containing two atoms each. Since these molecules of hydrogen, oxygen, nitrogen, etc., receive only two of the possible degrees of rotational freedom, they must be round and smooth with respect to one axis and not round or not smooth with respect to the two other axes. This condition is met if we suppose that these molecules are composed of two round atoms, attached to each other, but not entirely, if at all, coalescing to destroy their bipartite form. This gives the dumb-bell shape as the most probable form of these molecules, the dumb-bell possibly assuming, through various degrees of union of the parts, varieties of cylindroid, discoid, or even spheroid forms.

It is a curious fact that there are no gases whose value for the ratio of specific heats falls between 1.66 and 1.40. From the theory as developed above there is an interesting suggestion as to why this is so. It may be noted that, if the molecules have geometric relationship at all and occupy space to the exclusion of other molecules and if they be extended in any direction from the spherical form, they must be elongated in one *other* plane at right angles to the first elongation, *or an equivalent of this.* If, therefore, a molecule may be set in rotation in any one plane

through the effect of simple collisions, it may also be set in rotation in a second plane, thus giving two degrees of rotational freedom in the simplest case of a distorted or extended spherical form. This is the simple result of extension. Any straight line must lie in two planes, and each plane provides the possibility of a rotational degree of freedom. From the mechanical point of view, therefore, there should be no molecules with ratio of specific heats lying between 1.66 and 1.40 because there are no molecules with four and only four degrees of freedom.

To go a step further in the investigation, let Ei represent three degrees of freedom which might be the three degrees of rotation. This gives 1.333 as the ratio of specific heats. This might represent a molecule with three atoms arranged in the form of a triangle, or in the form of a curved line. To give the value 1.33, however, it would be necessary that the atoms be held rigidly in certain positions within the molecule. Since, according to our previous reasoning, the atoms are round and smooth, it is easy to suppose that such bodies would be unable to retain a rigid configuration in the midst of the tremendous bombardments to which they are continually subjected. At any rate, the tri-atomic molecules of water, hydrogen-sulphide, carbon-dioxide listed in the table do not behave as if they were rigidly maintained in the triangular form, for this would require a value of 1.33 for the specific heat ratio. Nor are the atoms arranged in a straight line, for this would require a value of 1.40. It is necessary, then, to seek a little further for the inner structure of these molecules. Let Ei represent four degrees of freedom, giving a value of 1.286 for the ratio. This value seems to fit very well all the tri-atomic molecules listed in the table. This may be the case in which the molecules have the three degrees of translational freedom, the three of rotational freedom, and another degree of some other kind. Possible the three atoms are arranged in the form of a clover leaf, giving the six degrees of translation and rotation, while the other degree might consist of the pair of like atoms revolving pin-wheel fashion about the other atom. It would not be wise to pursue the investigation further with assurance as the ratio values for the more complex molecules become more and more difficult to determine, and the mechanical operations within the highly complicated molecules admit of too many interpretations for a definite geometrical analysis. It may be noted also that the members of the halogen group, some of which chemists consider to be diatomic, do not fall into the interpretation as outlined above. It

may also be noted, however, that certain activities of the halogens seem to indicate a structure different from that of the simple diatomic atom. This suggestion opens an interesting problem which at present must be approached largely through conjecture.

The Size of Molecules.

If a thin edge one centimeter in length, made of some material to which water readily adheres, be held so that it merely touches the surface of clean water and then carefully lifted it will pull the water after it to a perceptible height above the general surface. The water clings to the edge until the raised mass has a weight of about 150 dynes, when the water column is ruptured by the stress of its own weight. As the edge is lifted, the surfaces of the water do not stretch, but are enlarged by molecules from the interior mass of the water passing into them. The molecules in the interior take practically no part in the lifting process because they move about among themselves with such freedom that they offer only little resistance to any displacing force. The force of 150 dynes, or half of this for a single surface, then, is the maximum stress under which molecules of water can force themselves, by virtue of their cohesion, into a surface. When this force of 75 dynes for any one surface of water is exceeded the strained surfaces cannot close themselves with molecules from the interior. This means that a ribbon of water whose thickness is that of a single molecule, with no interior molecules to replete the surfaces, thus allowing them to enlarge, and one centimeter in breadth, would be just about to break under a pull of 150 dynes of force. Thus a belt of water one molecule thick and two yards wide would resist a force of about one ounce.

Now let us take a cube of water, one centimeter in length on each side, and, proceeding on the assumption that the molecules of water are arranged in regular layers, a supposition which will not vitiate our investigation to any great extent, begin to tear off, in our mind of course, the top layer of the water as if it were a porous plaster sticking tightly to its neighbor layers. By taking hold of one edge, and pulling with a force of 150 dynes, the edge will begin to break loose from the mass of the water, and by pulling through a distance of one centimeter, the top layer will be entirely removed. The work done in removing the layer is 150 times the distance, one centimeter, or 150 ergs, and if x is the total number of layers in the cube of water one centimeter high, then the total work required to tear the cube of water into single layers

will be $150x$ ergs. Now let all the x separate layers be piled again into a cube and turned upon edge. In this position, the water may again be stripped into layers as before, giving x layers and requiring $150x$ ergs of work to do it. The cubic centimeter of water has now been shredded into strings of molecules each a centimeter in length. Let these strings be arranged in the cube, and stood upon end, and let blankets be torn off as before, requiring in this case, as in the others, x layers and $150x$ ergs of work.

The cubic centimeter of water, one gram, has now been theoretically, by hand as it were, separated into its individual molecules at an expenditure of $450x$ ergs of work, and the number of molecules is x^3 where x remains to be determined.

Resort must now be had to another experiment. If a cubic centimeter of water be converted into steam by the application of heat the molecules will likewise be separated from one another, and the amount of heat required to accomplish this is the 80 calories necessary to warm the water from a temperature of, say 20 degrees centigrade to the boiling point and an additional 537 calories necessary to convert the gram of heated water into steam after it has attained the boiling point. The total heat, therefore, is 617 calories which is equivalent to 25914000000 ergs work as the amount required to separate one gram of water into its molecules.

The molecules of water at a temperature of 20 degrees centigrade, the temperature at which the first experiment was made, had comparatively little energy of translation, while in the steam, they have, by our previous calculation, as seen in the formula above where the translational energy $Vmnv^2/2$ equals 3/2 times 1000000 times 1680, 2520000000 ergs of energy. The 1000000 used above is the value in dynes roughly of the atmospheric pressure, and the 1680 is the volume in cubic centimeters of steam resulting from the evaporation of one gram of water, at a temperature of 100 degrees. Another item by way of a correction must be considered. When the water becomes steam, its volume increases about 1680 times, and the amount of work done against the pressure p is 1680 times 1000000, or about 1680000000 ergs. By subtracting these two amounts from the total work required to convert the gram of water into steam there remains a corrected total of 2171400000 ergs, as the work required to separate the molecules by the heat method. There are other corrections which might be made but these two are probably the most important

ones, and practically leave the steam molecules in the same condition as in the theoretical method.

By comparing the two methods of separating the water into molecules, it may be seen that the $450x$ in the first case must represent the 21714000000 ergs in the latter case, and x turns out to be 48000000. This means that there are 48000000 water films, each one molecule thick, in a pile of water one centimeter high, or ,in other words, it takes 48000000 molecules of water to make a chain one centimeter long, or 122000000 of them to make a row one inch long.

The number of molecules in the whole gram of water would be the cube of 48000000, or 111000,000000,000000,000000, or in words, about one hundred eleven thousand million million million. In one pound of water there are about 50,000000,000000,000000,-000000 molecules, about as many to the pound as there are parts of the whole earth if it were done up in quarter-pound packages. If the pound of water were spread out in a film one molecule thick, it would cover about 550 acres, and if drawn out into a string the pound would extend 6,600000,000000 miles.

Knowing the size of the molecules, it is possible to obtain some idea of the forces exerted by water molecules upon one another. If a belt of water, one foot wide and one fourth of an inch thick, could be made in such a manner that all the molecules would act as if they were in the surface and had to exert their own proper force instead of running away from the points of stress, the belt would consist of 30000000 layers superposed, and since one layer would sustain a force of about 1/6 of an ounce, the whole 30000000 layers would sustain a stress of about 300000 pounds, as much as if it were made of strong steel.

THE LOWEST TEMPERATURE ON RECORD.—By the use of a specially constructed apparatus, in which helium was evaporated in a vessel surrounded by liquid helium, Professor Kamberlingh Onnes has succeeded in evaporating helium at a pressure of about two tenths of a millimeter. The temperature thus attained corresponds to about 1.8 degrees absolute.

SOME RESULTS OF A GENERAL SCIENCE COURSE.

By J. L. Thalman,
Oak Park, Ill.

Much has been said from time to time concerning the effect of an elementary science course upon the election of the advanced sciences later on, although there have been no definite data on which to base any conclusions.

In the Oak Park and River Forest Township high school we have had a prescribed course in elementary science for the past twelve years. During that time much material has been experimented upon, but the course, as given at present, has been practically the same the past three years. Thus the results below give a fair showing of the effect of our elementary science course upon the elections of our advanced courses for the years 1908-1912, inclusive.

Year	Total Enrolment	Number electing at least One Science	Per Cent	Number electing at least Two Sciences	Per Cent	Number electing at least Three Sciences	Per Cent
1908	113	60	53	25	22	5	4.4
1909	75	47	62.6	17	22.7	3	4
1910	134	82	61.2	26	20	2	1.5
1911	114	76	66	29	25.4	6	6
1912	124	83	67	29	23.4	6	6

In the table will be found first of all the total number of students graduated in the classes of '08, '09, '10, '11, and those expected to graduate in '12. Following this the number in each class who have elected respectively, at least one, two, or three sciences.

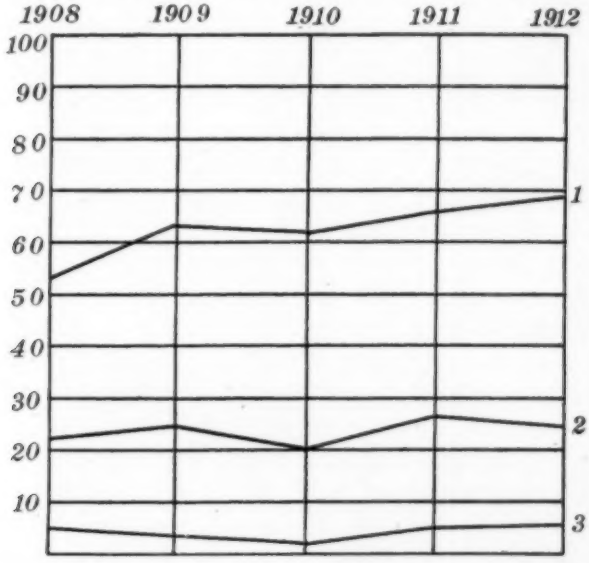
Elementary science is compulsory for all first year students and is prerequisite for the courses in botany, zoölogy, physical geography, chemistry, and physics, which are all electives.

Reference to the per cent columns shows the number electing at least one science to have increased for the period covered from fifty-three per cent in 1908 to sixty-seven per cent in 1912. Or stated differently the number electing at least one science in 1912 is over twenty-five per cent greater than the number electing one science in 1908—surely a gratifying increase. The per cent of those electing at least two sciences has increased from 22% in 1908 to 25½% in 1911 and to 23.4% in 1912, while the increase

of those electing at least three sciences is from 4.4% in 1908 to 5% in 1912.

It will thus be seen that the number of students electing the sciences in our school is decidedly on the increase.

The full significance of these figures is appreciated only when one understands the conditions and opportunities for electives. Of the sixteen units (a unit is the credit given for a full school year's work in a subject) required for graduation, nine units are prescribed, leaving seven to be elected. These may be elected



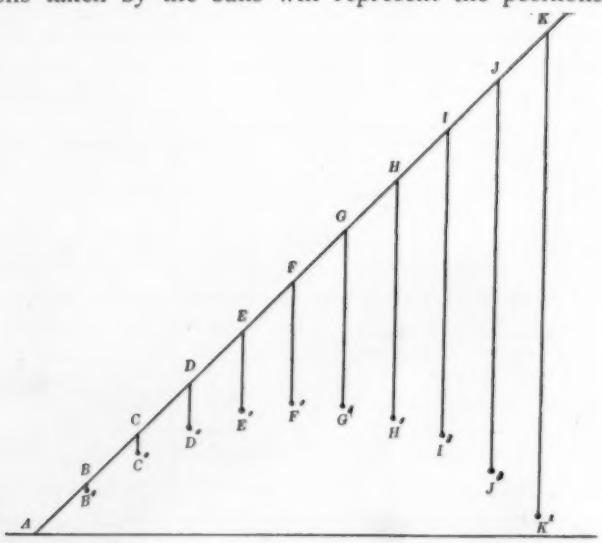
LINES 1, 2, AND 3 REPRESENT, RESPECTIVELY, THE PER CENT ELECTING ONE, TWO OR THREE SCIENCES.

from a field of over forty courses offered. But if a student elects Latin, he must complete three years of the subject for full credit, leaving but four electives; or, if he elects a modern language he must complete two years of the subject to receive any credit in it at all, leaving but five electives. For these four or five electives, as the case may be, he chooses from the above mentioned large number of courses offered. Science elections are steadily increasing and the time seems not far distant when all students graduating from our school will have had at least one advanced science in addition to his elementary course, which is the end desired for the student to gain the greatest benefit from the training received in the general science course.

A SIMPLE DEVICE TO ILLUSTRATE THE PATH OF PROJECTILES.

By John W. Scoville,
Central High School, Syracuse, N. Y.

A simple device to show to a class the path of a projectile may be made as follows: On a yard two stick take points, A, B, C, etc., at five inch intervals. At these points, suspend pieces of thread, each having a small ball (a shoe button, bead, or buck shot will answer) attached to its lower extremity. The thread at B is to be short (say half an inch) and the next threads are to be 4, 9, 16, etc., times as long as the thread at B. Then the positions taken by the balls will represent the positions of the



projectile at the end of successive seconds, the distance AB will represent the muzzle velocity of the bullet, the distance BB′ represents half the acceleration of gravity and the angle KAK′ gives the elevation of the gun. In five seconds the bullet would go from A to F if it did not fall and in five seconds it would fall a distance equal to FF′. Hence F′ marks the position of the bullet at the end of the fifth second. The inclination is easily changed and the corresponding effect on the projectile path noted. When the elevation is 45° the range is greatest and the highest altitude reached by the bullet is one fourth the range. If K is held directly over A, the balls show the successive positions of the bullet when the gun is fired directly upward; if A is held over K, the bullet is fired straight down.

THE OPPORTUNITY NOW BEFORE TEACHERS OF PHYSICS.

By J. M. Jameson,
Pratt Institute, Brooklyn.

The movement for industrial education now sweeping the country is of the highest interest to teachers of physics. It points the way to the fulfillment of a great opportunity for physics teaching, while, at the same time, emphasizing in no uncertain manner the necessity for general and most radical changes in the subject-matter and methods of the present preparatory physics if it is to retain a place of any considerable importance in the public school. It is time for physics teachers to recognize and to discuss the situation fully, for there can be no question as to the continued growth of the educational ideas of which the present agitation for industrial education is a direct outcome. These ideas appeal to the business sense of the public, and command, therefore, the support of manufacturers, of labor organizations, and of business men of all classes, who see in a school training for industrial life both the good of the community and advantages to their children, which they themselves did not enjoy but which experience has taught them would have been of inestimable service, and which the public schools, as now organized, do not provide. Under the spur of earnest conviction, national aid to industrial education is already projected; states are enacting compulsory education laws; communities, acting independently in their own interests, are appropriating large sums for the establishment of industrial departments in already existing high schools or for new buildings for technical and industrial high schools with both day and evening classes.

Thus far we have had an opportunity to observe mainly the increasing willingness with which the public purse is opened. But buildings and equipment do not necessarily make schools. The success of industrial education, measured by the amount of training of real value as a preparation for life which it succeeds in imparting, is yet in process of determination, and rests largely with school men—executives and teachers. Destructive criticism is always vastly easier than constructive suggestion. The best school preparation for the life that one is to live is rather a complex question, the answer to which will scarcely be supplied from a single point of view. The industrial educational movement in its larger sense, and its evidence of general public dissatisfaction with existing conditions, cannot fail to modify

the whole public school system. As more and more concrete information becomes available through the success with which different communities meet their particular educational problems, more definite standards will be available by which the work of public school teachers may be judged. And when one bears in mind that some ninety per cent of the pupils in our public high schools leave school to go to work and not to college, it would seem that the problem of all high schools is much the same, and that we are likely to find that the special terms "technical" high school or "industrial" high school, to distinguish from what may be called simply "the high school," are hardly warranted and likely soon to be obliterated. Some day—soon, I believe—instruction for the masses and not for the few will be typical of our public schools: if school men won't lead, then more power to the movement which stirs up a tax paying public. Not by any means least among the results which we may expect to grow out of the movement for industrial education is the reactive effect which shall bring about a modification and readjustment of the work and the aims of our old line public high schools, whose organization we had come to regard as pretty well fixed.

That education which prepares with directness for the life of a community, like all systems of education with elementary pupils, must not scatter its effectiveness through too great overloading of the daily program. The real backbone of any elementary school plan must be found in a few really fundamental subjects frequently and properly presented. To these must be given the bulk of the time schedule and an arrangement of periods which shall insure their proper presentation. Now no scheme of instruction can hope to train broadly and efficiently, in these modern days, in aptitude and initiative for meeting life problems as they arise, in capacity for growth rather than mere dexterity in a limited field, which does not provide generously for teaching the fundamental principles of all work and all work processes; which does not emphasize efficiency in the utilization of energy and what such efficiency involves; which does not provide for a quick comprehension of machines and mechanical processes of all types, and for initiative and capacity in thinking about practical affairs.

Instruction of this type belongs properly to the physics class room and laboratory, and in just the same measure as the training here briefly suggested is an indispensable preparation for modern life, physics of a kind to effectively provide it becomes

an indispensable part of the program of the public high school. Physics should not be an elective or a part time subject. It should take its place with English, mathematics and drawing as one of the fundamental and full time subjects of the public high school. And when physics teachers agree upon this fact, when they make physics an interesting, usable subject of everyday life instead of a formal, abstract discussion of only historic interest, this in my judgment is the position to which it may soon arrive. To put the matter forcibly if inelegantly, "it is up to us" as physics teachers whether we will develop a type of instruction which shall win confidence, appreciation, and standing *through the results that it obtains,* or whether we will permit our subject to be displaced because dry, formal, and of little real application. For certainly the newer standard of values now shaping will find little worth in the prevalent type of preparatory physics.

This development of elementary physics to fit the conditions of modern life will take time, and will require united effort and discussion on the part of physics teachers. It will involve several radical changes in the selection of material to be taught, in the manner and order of presentation, and in laboratory equipment. In the first place, we are now covering altogether too much ground and presenting too many unrelated ideas for the immature mind. High school physics is too often a high speed commentary on all the field of physics—a sort of abbreviated encyclopedia of facts, and like encyclopedias in general, pretty dry and unproductive. I wonder why physics teachers feel that this is necessary? A secondary school course in any subject is necessarily incomplete, and why should not its incompleteness be that of some real accomplishment in a few selected topics rather than an entirely inadequate and unsatisfactory attempt at many topics? There is always interest and satisfaction in digging into a thing until we feel that we really know something about it in a full and usable sense. We may make our teaching much more effective by selecting for study and discussion a few of the larger, more important, general principles and then making these stand out sharply, unclouded in a mass of lesser ideas.

Then, again, we should select topics and problems more suited to young minds and more intimately associated with the everyday life of the pupils. This may mean widely different equipment and widely different treatment in different communities and schools. If so, all the better: we do our best teaching when not too greatly tied to precedent and the written requirements set

only too often by those least familiar with the actual conditions under which we work. Our present requirements in physics and our present laboratory exercises as laid down for college entrance have been developed from the wrong end. Science as one grand whole, each part beautifully fitting in with and supplementing the others, is a splendid conception—but it does not develop that way. That is a backward view after one has reached the summit, not a forward one as the beginner is climbing. This or that principle has a positive fascination for the trained mind, viewed with regard to its ability to make clear these other heretofore difficult questions or with regard to its relation to the whole chain of scientific reasoning, but this is no reason why it is or should be equally fascinating to the mind of a normal boy or girl, nor does their lack of response furnish legitimate ground for calling them stupid. Merely stripping a university exercise of some of its external difficulties, through such simplification of the apparatus that a secondary school pupil is able to manipulate it and thus "go through all the motions," does not make it a fit exercise for such pupils. The *ideas* are still wrong because so unsuitable. They are capable of arousing interest only in a mature mind interested primarily in the subject. Never by any amount of conscientious drill on the part of teacher or pupil, can they be made to produce such an effect upon the mind of the boy or girl. And after all, our problem is not physics as physics; it is just boys as boys and girls as girls. Suppose in the end we have not built the foundation complete to every last detail, suppose some of our ideas do go into the first story or the second story or the roof of the completed structure, they will gradually fall into their proper place as the pupil gains in experience and knowledge, and in the meantime we have given him something real and worth while to work with, something which enables him to explain things in which he is interested, information which enables him to *do* things.

And not only do we often attempt to force upon immature pupils exercises which are unsuitable and lacking in intrinsic interest, but we too often follow a wrong order in presenting the work. To build up from fundamental principles, step by step, ending with the applications of the principles, is not the order of greatest interest nor is it the order in which knowledge is oftenest acquired. A better method, both with regard to total actual accomplishment and with regard to the time saved, frequently is to plunge into a bigger problem, and then gradually

sort out and arrange our facts until a satisfactory understanding is arrived at. This method develops initiative and self-reliance. It trains the pupils to use the information they already have, and does not squander time over intuitively known or self-evident facts, which if assumed and used, readily become a part of a student's working knowledge without the necessity of formal demonstration. This method, too, puts such interest killers as exercises in measurements in their proper place as a means to an end, not an end in themselves. The time to measure a length is when the length is required for definite use, as for example, a moment arm, the height of a mercury column, the length of a beam, the length of a wire under test, etc. The time to learn the principle and use of the micrometer is when it is required for measuring a necessary value as the expansion of a rod by heat, the deflection of a beam, etc., and the time to learn to use a vernier is when required to read a barometer or other vernier instrument. And these, also, are the occasions on which to teach the pupil to really appreciate the problem he is undertaking, and the character and value of the information he is obtaining, through directing his attention to the degree of precision required in different operations and the proper use of significant figures in expressing his result. We not only fail to teach our students all we should, but we are doing them positive harm when we permit them to weigh the water in a calorimeter to 1/100th of one per cent when they cannot possibly determine the temperature change to better than two or three per cent; or when we accept a P V product carried to seven significant figures or a modulus of elasticity expressed to four decimal places.

This method of attacking the problems of physics on a larger scale would bring about a much-needed change in the character of the equipment for the physics laboratory. Physics which is to be usable, and which is not to be left behind when the class room or laboratory door is shut, must deal with the real apparatus of everyday life and not with special affairs of extraordinary refinement, never encountered outside the laboratory. For several years past, the department of physics at Pratt Institute has been endeavoring to develop a series of laboratory exercises for use with classes in mechanics, heat, and electricity, which would reproduce, as far as feasible in a school laboratory, actual commercial problems, or which would present fundamental principles and laws under the conditions in which they are met in life. The apparatus for these exercises has been built largely in the Insti-

tute shops, as far as possible from commercial parts, and of a size to suggest possibilities of actual use and thus command both interest and respect. The lack of delicacy in the case of certain pieces has been found to be more than made good by the particular opportunity which such apparatus furnishes for training in initiative and judgment in securing data, in avoiding or correcting for errors, and in determining to what extent the results obtained express a natural law or depend upon purely accidental conditions.

The results reached through these exercises indicate that the efficiency of the instruction in the fundamental principles of physics has in no way been diminished, while at the same time, there has been a marked increase not only in interest but in the ability of the students to apply their physics, and in their general resourcefulness, quickness of perception, and power of accomplishment. As these are the kind of results in physics teaching that the writer has been urging throughout this article, it is felt that perhaps no better argument could be made than to outline some of these exercises in considerable detail. It is not claimed for them that they are perfect or the "last word on the subject." It is hoped, however, that some of them may prove suggestive, and that they may arouse discussion and criticism, which not only will enable the writer to improve upon his own suggestions, but may also be of value to other teachers of physics. It is only through some such mutual effort and exchange of ideas that physics teaching may hope to realize the great possibilities now before it.

GROUP I. APPLICATIONS OF THE PARALLELOGRAM OF FORCES.

The single exercise with three forces applied to cords attached at a common point, as usually given on the principle of the parallelogram of forces, while an excellent introductory exercise, is of little real value unless followed by others in which the principle is to be applied under more actual conditions. It is often astonishing to discover how apparently clear this law is in its book form to pupils who are unable to make the slightest progress in applying it in the determination of the forces in the members of a simple actual structure. And certainly mechanics to be valuable must be usable. There should be, in every physics laboratory, several small models of simple practical structures with which the pupil may study for himself the application of the law. In these, the load applied and the weight of the parts, where necessarily considered, should be assumed as the only known forces,

and from these, the forces in the different members of the structure are to be determined. Angles, dimensions, etc., are to be taken from the apparatus as required. The computed results are to be checked in every instance by comparison with the readings of spring balances inserted in the members of the model. The greater the variety of apparatus the better. It is not necessary that each pupil should work with every piece; much will be learned from mere observation, from discussion of the results obtained by others, etc. Among exercises applying the principle of the parallelogram of forces, the following are suggested as having been found satisfactory:

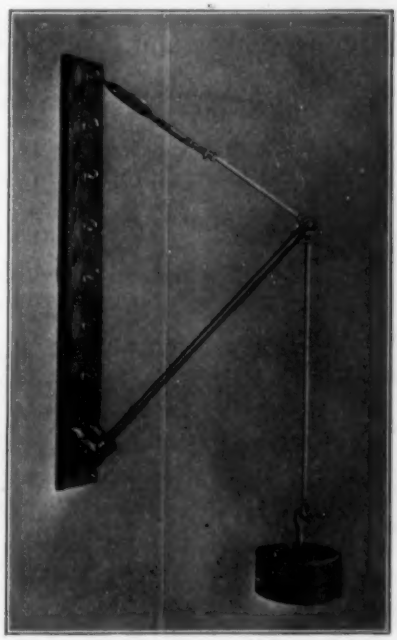


FIG. 1. STICK AND TIE.

(*a*) THE STICK AND TIE.

This apparatus will be clear from Fig. 1. The directions to the student and the operations that he is to perform may be similar to the following suggested form, in which B indicates the end of the stick at the support, C the outer end to which the tie is attached, E the hook vertically above the foot to which the tie is fastened, and L the load.

EXPERIMENT 11—6. THE FORCES IN A SIMPLE STICK AND TIE.

(From Physics Laboratory Notes, Part I. Copyright 1911, by J. M. Jameson, Brooklyn, N. Y.)

Apparatus in the Laboratory: Stick with foot support; two spring balances; scale pan and weights.

Apparatus from the Stock Room: Large protractor.

Arrange your apparatus as in the diagram. The stick BC should not be horizontal. Make the weight L large enough to stretch balance F almost to its full scale reading. The weight of the stick is here so small in comparison with the other forces that it may be neglected.

Measure the angles BCL and ACL and weigh L.

By means of a diagram, drawn carefully to scale, find the tension in AC. Check by reading the balance F and comparing it with your result.

By the same diagram, find the compression BC must stand. Test this by attaching a second balance at S and pulling out in the line of the stick BC until the end of the stick at B just leaves the wall. This pull checks the compression in the stick BC, with which it should be compared.

Record on your diagram all necessary angles and readings.

Change the angle of the stick to the wall and repeat your tests, making the necessary diagrams and taking check readings as before.

Problem: A stick, BC, 10 feet long, is at an angle of 42° to the vertical. The tie CA is horizontal. The load L, is 2 tons. Compute the tension in CA and the thrust against the foot at B.

It will be observed that this exercise illustrates the principle of the derrick. An instructive variation of the problem will be found in changing the angle of the stick to the vertical, the direction of the tie, etc., and noting the effect upon the tension in the tie and the compression in the stick for the same load.

(*b*) THE SIMPLE ROOF TRUSS.

The construction of the model will be evident from the photograph, Fig. 2. The joint at the apex is a freely moving pin

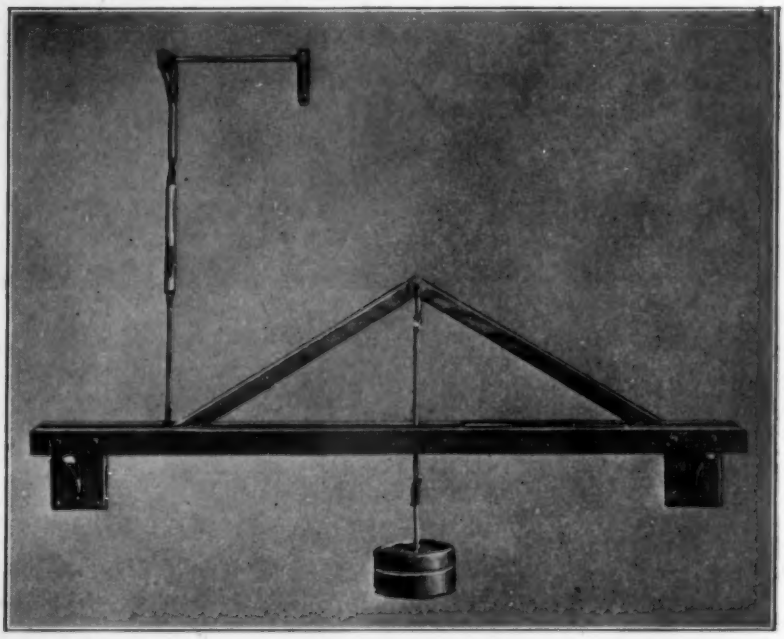


FIG. 2. MODEL OF A ROOF TRUSS.

joint. The lower end of one stick is held rigid by a pin through the frame which serves as a guide to keep the truss vertical, and

the lower end of the other stick is "floating," held by the vertical and horizontal cords, which supply the vertical and horizontal reactions at that end. Either end may be floated as desired.

In use, a load L is suspended from the apex and the vertical and the horizontal cords are then adjusted. The total load at the apex is then L plus ½ the weight of the side members, provided these are uniform in size. The student may now measure the necessary angles and determine the compression in the sticks graphically by the parallelogram of forces. The horizontal component of the compression in the sticks now gives the tension in the horizontal tie which keeps the feet from spreading; this may be checked by comparison with the reading of the balance inserted in the tie. The vertical component of the compression, plus one half of the weight of a stick, is the vertical pressure at the foot. This may be checked by comparison with the reading of the balance in the vertical cord.

The exercise may be made even more suggestive if, in place of a single load suspended from the apex, we apply a distributed load over both members by means of heavy iron or lead slabs. The conditions are then those of an actual truss with the roof, wind, snow, etc., loads. If uniformly distributed, a half of the total load on each stick may be regarded as acting at each end; if not uniformly distributed, the center of gravity of the slab may be found, and from this the relative amounts at each end may be determined. The solution is then to be completed as before, using as the load only the weight that comes on the apex. The student should notice that the half loads at the foot of the sticks merely produce vertical pressures on the supports and are not to be considered in computing the compression in the sticks, also that where the side loads are not the same, the horizontal components of the thrusts at the feet are equal while the vertical components are different.

(*c*) THE SIMPLE TRUSS.

The stick and tie shown in Fig. 1 when arranged as in Fig. 3 with the stick horizontal, furnishes an illustration of a common simple truss construction. The data and the graphical solution for the tension in the tie and the compression in the stick are here the same as for the stick and tie, and check readings are obtained in the same manner. Or, if desired, the apparatus may be used as a simple illustration of the analytical conditions for the equilibrium of concurrent forces in one plane. The force in

CB having been resolved into its rectangular components, we have the horizontal component, H, equal to the pull required to free the foot of the rod from the wall, and the vertical component

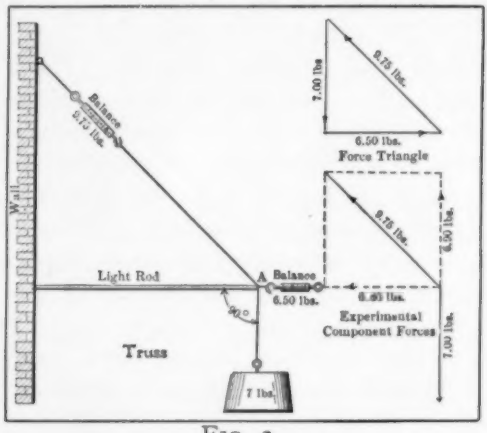


FIG. 3.

V equal to the load suspended from B. The student thus has an illustration of the general equations, Sum X = 0, and Sum Y = 0, in their simplest form.

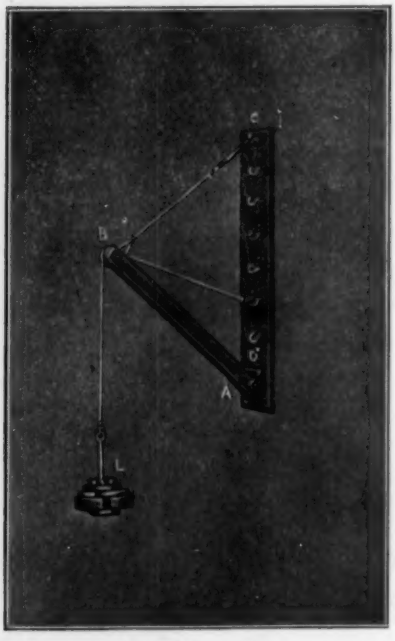


FIG. 4. MODEL OF A HOISTING CRANE.

(*d*) THE HOISTING CRANE.

This exercise may be performed with a small commercial floor crane or with the wooden model shown in Fig. 4. This model uses the same back board and foot support as Figs. 1 and 3, with a heavier jib fitted with a pulley, in place of the light rod. The construction will be apparent from the figure. A clevis at B, to which a second balance may be attached, enables the student to pull outward in line with the jib until the foot A is just free from the pin and thus check the computed compression in that member. The procedure for the exercise will be seen from the following suggestion for a student direction sheet.

EXPERIMENT 13—4. THE HOISTING CRANE.

(From Physics Laboratory Notes, Part I. Copyright 1911, by J. M. Jameson, Brooklyn, N. Y.)

Apparatus in the Laboratory: Rod with pulley and foot support; two spring balances; scale pan and weights.

Arrange your apparatus as in the figure. DBL is a continuous cord from the reel, supposed to be at D, over the pulleys at B to L. The tension in this cord is to be assumed as the same on both sides of the pulley.

Weigh the load L and the boom AB. Consider the load L and weight of AB as the known forces. Half of the weight of AB is to be taken at A, half at B. Measure the necessary angles.

Contruct a force diagram for the point B, and solve for the tension in the tie CB and the compression in AB.

Compare the computed tension with the balance reading at C, and the computed compression to the pull required to free the end A of the stick from the pin. Indicate all computations.

Note: In reading the balance at C, care should be taken to get rid of the effects of friction. This may be done by tapping the member AB, and after the balance comes to rest, taking a reading. The average of several readings so taken should be accurate. Angles should be obtained as in Exp. 11-2.

The forces at B are to be resolved graphically or by simple trigonometry and the values of the horizontal and vertical components expressed in terms of the whole force. Then, since the components to the right of B must equal the components to the left, and the components upward must equal the components downward, two equations may be written from which the tension in BC and the compression in BA may be found. Or if preferred, the method of the graphical polygon may be employed for the solution.

(*Continued in the April issue.*)

GEOLOGY A HELP IN BUILDING CONSTRUCTION.

Economic geology is a science which is frequently invoked in determining the commercial availability of structural materials. No one better than the trained geologist can determine from its age, structure, and composition whether a deposit of rock or clay, for instance, is capable of being put to a successful commercial use. In addition to certain specific geologic investigations to determine the value of raw building materials, the geologists of the United States Geological Survey, as incidental to their other work, which carries them to all parts of the United States, are constantly observing and reporting on deposits of such materials which they may chance to encounter.

A PROPOSED SYLLABUS ON BIOLOGY.[1]

Owing to the indefiniteness of our instructions your committee on Syllabus for Biology Courses in the High School has not felt that it should undertake to prepare a definite outline of study. We have contented ourselves with a statement of what we consider the purposes which should control the formation of such a syllabus and the selection of text-books, together with an intimation of the general types of topics which should be represented.

I. Such a course should seek the following, among the possible things:

1. The production and conservation of a vital interest in plants and animals.
2. An appreciation of the human values of plants and animals.
3. The encouragement of the attitude of raising and solving problems concerning plants and animals.
4. Some ability to use the library, the field, and the laboratory in individual pursuit of these interests.
5. The ability to sustain interest in these problems through considerable periods.
6. A sense of organic response to the environing conditions.
7. An elementary conception of development and of the evolutionary series of animals and plants.
8. Some knowledge of living material; its organization in plants and animals; its properties and the relation of these to the activities of the organism.
9. Some experience in classification of organisms—theoretical and practical.
10. A conception of the place of man in the biological series, along with the conviction that this does not invalidate, but rather heightens, the meaning of all the higher human qualities.
11. A sane, wholesome appreciation of the origin and meaning of sex, and of its bearing on human life.

The committee believes that it is not desirable, even if possible, to have uniform courses in biology in the different schools of the state. We believe, however, that all exercises in all schools should be handled in such a way as to secure the "scientific habit," which includes among other things—the habit of correct observation; of accurate expression of these observations both by means of notes and drawings; of discriminating between superficial and essential observations; of correct thinking; and of willingness to retest the final conclusions when new evidence appears.

II. In order to do these things in zoölogy, the following among other possible exercises should be included:

[1] Offered by the Standing Committee of the Biology Section of the High School Conference at the University of Illinois, Nov. 23-29, 1911. The committee consists of T. W. Galloway, Guy L. Koons, W. W. Whitney, O. W. Caldwell, Faith McAuley, and T. L. Hankinson.

1. Exercises specially introducing to the local field, and showing the general relation of animals to their surroundings. By field is meant the whole outdoor *natural* resources of land and water and air, reasonably available to the student, whether extended or limited.

[The time estimates below are purely provisional and suggestive and are expressed on the basis both of ½ year in zoölogy (first figures), and of 1 year (second figures). The numerators represent periods devoted to laboratory or observational work; the denominators text-book or reference work. It is not implied that this order of exercises is essential.]

Time: 3—1 — 5—1 periods.

2. Exercises introducing to the somewhat artificial resources, as fields, gardens, greenhouses, barnyards, zoölogical gardens, stock yards, museums, etc.

Time: 3—0 — 5—0 periods.

3. Exercises introducing to the library and all related helps, and the best method of using them.

Time: 2—4 periods.

4. Similar exercises introducing to the laboratory and its apparatus, and the method of using to advantage.

Time: 2—4 periods.

5. Exercises of collecting, note-taking, and rough identification of the common types of animals by means of pictures and descriptions, and by the use of keys.

Time: 5—8 periods.

6. The careful study of some representative animal that will suitably and convincingly illustrate the general adjustment of animals to the surroundings, the differentiation of organs, and the relation of these organs to the work which must be done by the organism (ecology, physiology, and morphology).

Time: 14—1 — 14—1 periods.

7. A series of exercises developing inductively the observable differences between inorganisms and organisms; and between plants and animals.

Time: 4—4 periods.

8. Exercises to show the nature of the main phyla of animals and their progressive character. These should include at least the protozoa; the worms; the mollusks; the arthropods; and the vertebrates, inclusive of man.

Time: 15—15 — 30—30 periods.

9. A group of exercises to stress the points at which animals most deeply touch human welfare, both directly and indirectly.

Time: 5—1 — 15—1 periods.

10. Exercises calling for the continued study of some type or types, in natural conditions, through the whole period of study. Calendar studies.

Time: Scattered through year, but aggregating 10—20 periods.

11. Some studies specifically illustrative of variation, of the struggle for existence, of heredity, and other similar aspects of evolution (inclusive of human variation, etc.).

Time: 8—7 — 15—15 periods.

12. Exercises especially emphatic of the general relations which animals sustain to the broad surroundings (ecology)—leading toward the problems of distribution.

Time: 1—3 — 3—7 periods.

13. Studies illustrating the steps in the life-cycle of animals.

Time: 1—3 — 5—5 periods.

14. Certain studies, both from field and library, appealing to the decided native interests; and illustrating beauty, strangeness, complexity of habits or instincts, or some other of the extra appeals to wonder. To be used at the beginning and through the course, when needed for motivation.

Time: 2—3 — 3—7 periods.

III. The following topics and exercises are important for use in the course in botany. It is recommended that these topics be studied in a synthetic way rather than by division into the leading heads of botanical science. Important literature which presents the significance to men's interest in the study of plants should be made available for constant use throughout the course. It has not been thought best to set definite time limits to each of the topics.

1. Local plant areas:
   (a) The types of natural plant areas of the local region, as forests, stream banks, roadsides, and swamps.
   (b) Local artificial plant areas, as a cornfield, garden, or planted forest.
   (c) Acquaintance with the more common plants that are dominant in local areas.

2. The seed plant as a working unit—an outline study of the general structure and work of the parts of the plant; the way in which each contributes to the whole plant as a working machine; include food manufacture and the essentials of plant nutrition, reproduction, etc.

3 Special study of the regions of seed plants—roots, stems, leaves, flowers, and seeds, with emphasis upon function in so far as function may be determined by observation and experimentation. Include nutrition and reproductive processes.

4. The bacteria: studied as instruments of decay, and disease; general hygienic aspects; relation to soils, and industries.

5. Parasitic and saprophytic plants other than bacteria; destructive fungi in relation to crops and other industries; importance of saprophytes as instruments of decay; the yeasts and fermentation.

6. Forests: uses, distribution, dangers, preservation, artificially grown forests.

7. Artificial control and methods of improving plants—plant culture and plant breeding.

8. Plants and the struggle for existence; overproduction and failure of those that cannot secure the necessities for life. Weeds as illustrations of successful plants in the interrelationship of plants and animals in open nature; cultivated plants as illustrations of success under artificial care.

9. The geographical and regional distribution of plants: plants of different zones, and of different regions as hydrophytes, mesophytes, and xerophytes.

10. The great groups of plants: where they grow; order of increasing complexity, and general outline of the evolution of nutritive and reproductive structures.

THE COLORADO RIVER BASIN.

There is no more interesting river in the world than the Colorado. Industrially, scenically, and geologically it presents more diverse conditions than any other stream in the United States. From the crest of the Rocky Mountains in Colorado and Wyoming it sweeps across the intervening country, traversing parts of Utah, New Mexico, Arizona, and Nevada, to the head of the Gulf of California, the area drained being about 300,000 square miles. In the Rocky Mountain region it flows through a country covered by eternal snows and waters some of the most fertile and valuable agricultural lands in the world in western Colorado, northwestern New Mexico, and eastern Utah. It traverses the famous Grand Canyon of the Colorado in the northern part of Arizona and finally passes over the broad, flat plains above the head of the Gulf of California. In this lower-most portion the river strongly resembles the Nile, having annual floods which distribute silt over the adjoining lands and render them as fertile as those in the historic valley of North Africa. The Colorado and its tributaries have other values than that of irrigation, for, descending in steep channels, they present abundant opportunities for the development of water power. Power has been developed at a few points, but the resources of the Colorado basin are in this respect yet practically untouched.

In a basin so liberally provided with natural resources it is a fundamental necessity, in planning for the utilization of the river, to ascertain the amount of water available in the main stream and its principal tributaries, so that future developments, as well as those now under construction, can be suitably designed in type and capacity. For a long period of years the United States Geological Survey has been making observations and measurements at many important points in the Colorado basin, and the latest published information on the subject is contained in Water-Supply Paper 269 of the Survey, which is a progress report of river-flow measurements in this basin for the year 1909.

The control of the Colorado for the prevention of outbreaks must involve thorough knowledge of the tributary flow, even in the high regions of its headwaters, in Colorado, and the ultimate steps taken to prevent disastrous inundation will in all probability involve the control of these upland tributaries.

The size of the Colorado River is indicated by its total discharge in the year 1909, which was 26,000,000 acre-feet, or enough water to cover that number of acres to a depth of 1 foot. Such an amount of water, if poured upon Manhattan Borough of the City of New York and confined by retaining walls, would bury the city 1,857 feet deep, or it would make a lake 66 feet deep over the State of Delaware.

CHAPTERS IN THE HISTORY OF AMERICAN BOTANY.

By John M. Coulter,
University of Chicago.

Forty Years of Plant Morphology. II. (1890-1900).

Ten years of contact with the modern phases of morphology had aroused American botanists thoroughly to the great possibilities of this subject. Not only did they begin to develop it themselves, but groups of the younger men sought training in the laboratories of Germany, chief among which was the laboratory of Strasburger at Bonn. If any man were named as dominating plant morphology during the decade beginning with 1890, it would have to be Strasburger, and the results of this influence became apparent not only in the problems attacked by American botanists, but also in the teaching which they guided or advised. The development of the subject during the decade may be indicated for convenience under three phases.

The morphology of the preceding decade was content with cells as the units of structure; and their form and arrangement in tissues, and the distribution of these tissues in mature organs, were the chief subjects for investigation and for teaching. In a very real sense, the morphology of that period was anatomy, variously styled "minute" or "internal," to distinguish it from the gross superficial anatomy of a still earlier period. This work, however, so stimulated the development of the microscope and of the technique connected with it that morphologists became equipped for the next advance. This was an attack upon the structure of the cell itself, which developed the new subject "cytology." Cytology, so far as it deals with structure, is simply morphology pushed to the limit of technique, a still more "minute" morphology. It is clear that not much cytology could be used in elementary instruction, but it became very conspicuous in investigation and in advanced courses, and its more obvious facts were brought to the attention of beginners. Such enthusiasm was aroused for this newly-opened region of investigation that cytologists almost seemed to represent a new cult, quite separate from other botanists, and quite sure that their facts were the most fundamental, and therefore the most important.

Another phase of morphology developed another cult, apparently not so distinct as the cytologists, for its members still retained the more general title of morphologists, but their morphology was just as special as was that of the cytologists. In the

former decade mature structures were of sufficient interest to hold the chief attention, but the advance in technique not only made cytology possible, but also permitted the study of developing organs. In this way ontogeny began the accumulation of its enormous array of facts. The structures chiefly attacked in this way during the decade were what may be characterized as the reproductive structures, as distinct from the vegetative structures. The ontogeny of the sex organs of all groups, and of the structures associated with them, of the spore-producing members, and of the embryo, furnished abundant problems for this group of morphologists. We began to talk of "stages" in the history of organs, of obtaining "complete series," of "filling in gaps," etc. The rigidity of the previous decades, however, was carried over into the new, and exact definitions were formulated for a growing terminology. Cell generations of developing organs were followed in the greatest detail, in the full belief that all the details had been cast in rigid molds and must be repeated with exactness by every developing organ. "Stages" of different plants were compared, matchings and differences were noted, and conclusions as to relationships were drawn. The effect of this morphology upon instruction was immediate and extensive. The few "types" of the earlier decade were abandoned, and an increasing range of forms was introduced to illustrate the various phases in the development of reproductive structures. Instead of asking all imaginable questions of one plant, a few questions were asked of as many plants as possible. While this method did not include so wide a range of plant structures as the older, it certainly brought a wider range of contact with plant groups. It was in connection with this phase of teaching that school and college laboratories began to make larger demands for equipment, that complaint began to be heard that botany had become a laboratory study rather than a field study, and, most of all, that a student could take any amount of botany, and still not be able to tell the names of any of the plants of his neighborhood!

The third phase of plant morphology that began to dominate during the decade was an inevitable accompaniment of the one just described. The comparison of ontogenies led on to the construction of phylogenies, and morphology became a study of the evolution of the plant kingdom, chiefly on the basis of a comparison of the reproductive structures. The reproductive structures were selected for use simply because they could be connected serially; while the vegetative structures, so long and so laboriously

studied, were set aside as anatomical rubbish. As a consequence, there were many students who knew something about sporangia, archegonia, embryo sacs, etc., but who knew nothing about the structure of leaves and stems and roots. With the emphasis laid upon the evolution of the plant kingdom, only those structures were selected for study that could be used in this way, and from this point of view vegetative structures stood merely for a chaotic mass of facts. The whole problem of teaching morphology is like the problem of a picture puzzle. The purpose is not to study each separate piece, but to fit together as many pieces as possible. The morphology we have been considering was doing just that. It could fit together the reproductive structures, and so it taught just as much of the picture as was constructed, but it recognized all the time the numerous pieces representing vegetative structures which must also be fitted together before the picture could be complete.

The last decade of the nineteenth century, therefore, so far as plant morphology in America is concerned, may be thought of as the coming into prominence of cytology, ontogeny, and phylogeny.

IMPORTANT CHANGE IN THE HOME UNIVERSITY LIBRARY.

Messrs. Henry Holt & Co. announce that experience thus far with The Home University Library, has shown the prospect of a larger market at a lower price sufficient to induce them to change the books to a form which can be sold at 50 cents instead of 75 cents a volume.

Ten volumes of this series appeared in May, 1911; eight more the following August; eleven more are just ready, and sets of about ten volumes each will appear every few months until at least 100 volumes have been issued.

The publishers find it necessary to emphasize that these are absolutely new, copyrighted books; each written within 18 months expressly for this series. They are not imported sheets, or sweepings from authors' desks, but absolutely new books of reliable information, each by an authority, written especially for the ordinary reader, and each a part of a comprehensive and carefully-planned scheme. The eleven new volumes are: "The Civil War," by Professor F. L. Paxson; "The Dawn of History," by Professor J. L. Myres; "The Papacy and Modern Times," by Rev. William Barry; "A History of Our Time (1885-1911)," by C. P. Gooch; "The Civilization of China," by Professor H. A. Giles; "Modern English Literature," by G. H. Mair; "Astronomy," by A. R. Hinks; "Physical Research," by Professor W. H. Barrett; "An Introduction to Science," by Professor J. Arthur Thomson; "The Evolution of Industry," by Professor D. H. Macgregor, and "Elements of English Law," by Professor W. M. Geldart.

THE TEACHING OF MATHEMATICS IN THE NORMAL SCHOOLS OF THE UNITED STATES.

PRELIMINARY REPORT OF COMMITTEE APPOINTED BY THE AMERICAN COMMISSIONERS OF THE INTERNATIONAL COMMISSION ON THE TEACHING OF MATHEMATICS.

COMMITTEE.

E. H. Taylor, Chairman, Eastern Illinois State Normal School, Charleston, Ill.

H. Clay Harvey, Chairman Subcommittee on State Normal Schools, First District Normal School, Kirksville, Mo.

M. E. Bogarte, Chairman Subcommittee on Private Normal Schools, Valparaiso University, Valparaiso, Ind.

J. C. Brown, Chairman Subcommittee on Teachers in Normal Schools, Eastern Illinois State Normal School, Charleston, Ill.

SUBCOMMITTEE ON STATE NORMAL SCHOOLS.

S. F. Parsons, Northern Illinois State Normal School, DeKalb, Ill.

J. D. Faught, State Normal School, Marquette, Mich.

J. C. Stone, New Jersey State Normal School, Montclair, N. J.

W. A. Cornish, State Normal and Training School, Cortland, N. Y.

G. C. Shutts, State Normal School, Whitewater, Wis.

W. C. Vernon, State Normal School, Austin, Tex.

SUBCOMMITTEE OF PRIVATE NORMAL SCHOOLS.

T. W. Keenan, Western Normal College, Shenandoah, Ia.

F. L. Pauly, National Normal University, Lebanon, O.

A. J. Harpman, Southern Minnesota Normal College, Austin, Minn.

SUBCOMMITTEE ON TEACHERS IN NORMAL SCHOOLS.

J. V. Collins, State Normal School, Stevens Point, Wis.

J. H. Scarborough, Second District State Normal School, Warrensburg, Mo.

D. S. Wright, Iowa State Teachers College, Cedar Falls, Ia.

G. W. Hull, State Normal School, Millersville, Pa.

This report is composed of three parts, namely, the report of the Subcommittee on State Normal Schools, the report of the Subcommittee on Private Normal Schools, and the report of the Subcommittee on Teachers in Normal Schools.

THE REPORT OF THE SUBCOMMITTEE ON STATE NORMAL SCHOOLS.

Preface.

The State Normal Schools exist for the purpose of training teachers for the public schools. They are generally supported

by appropriations by the state legislatures. A small number of these schools are supported by a specified state tax, supplemented by appropriations by the state legislatures, and in a few cases they receive some income from the sale or rental of public land grants. A few state normal schools have small permanent endowments. Tuition is free, except for slight incidental fees, to persons declaring an intention to teach in the state in which the school is located. With the exception of a few schools in the South the state normal schools are coeducational.

This report is prepared from data obtained from the catalogs of state normal schools, and from the answers to questionnaires. A questionnaire was sent to each of 185 state normal schools and to eight city training schools. Answers were received from sixty-five state normal schools and from three city training schools. The number of city training schools from which data was received being small, these schools have been included with the state normal schools.

The Actual State of the Organization and the Methods of Instruction in Mathematics in Normal Schools.

I. *The Relation of Normal Schools to Other Schools.*

Entrance requirements and courses of study. Of sixty-four schools reporting on entrance requirements, twenty-three per cent require high school graduation. The majority of these schools are in New England and New York. These schools offer a two year course of study which is composed largely of professional work. The remaining schools require for admission only the completion of the work of the eighth grade. Such schools usually offer two courses of study, a four year course for the students who have completed only the work of the eighth grade and a two year course for high school graduates. A few schools, chiefly in the Middle West, offer two years of work in addition to the above courses, for the completion of which a bachelor's degree is granted.

Relation to colleges. The work of the normal schools now receives better recognition from the colleges than formerly. Of the schools reporting to this committee fifty-six per cent receive full credit in the colleges for work done in mathematics, and twenty per cent receive part credit. Frequently the colleges allow junior class standing to the graduates of the normal schools. It is estimated that about thirteen per cent of the

graduates of the normal schools later pursue advanced work in college. The larger estimates come from the West, where because the high schools are not so well developed the normal schools are used as preparatory schools by a considerable number of students from the rural districts. Since a good number of their graduates later go to colleges, the schools of this section have come to offer considerable elective work. It thus becomes possible for the student to do in the normal schools the mathematics usually done in the first two years in college.

Schools in which graduates teach. Practically all normal school graduates later teach in the public schools. It is estimated that seventy-three per cent of the graduates teach five years or more. The large majority of them teach in the grades. Sixty-four per cent of the schools report that some of their graduates teach in the high schools in the smaller cities and towns.

II. *The Aim of the Instruction in Mathematics.*

Culture and utility. Of the schools reporting on this question, fifty-one per cent claim to pay equal attention to mathematics as a science (the so-called culture value), and to mathematics as an art (the so-called utilities of the subject). About twenty-eight per cent claim to emphasize more the culture aspect (except arithmetic), and twenty-one per cent emphasize the utilities more.

Preparation of teachers. Since a large majority of the students are preparing to teach in the elementary schools, arithmetic is the most important subject in the mathematical curriculum in the normal school. The mathematical instruction has as its chief aim to prepare efficient teachers of arithmetic. One means used to accomplish this end is to give formal instruction in methods of teaching. Of the schools reporting, eighty-nine per cent give courses in methods of teaching arithmetic, and nine per cent give courses in methods of teaching algebra and geometry. The general opinion is that such courses are distinctly valuable when preceded by a thorough grounding in the subject-matter. In sixty-six per cent of the schools offering these courses they are given wholly, and in eight per cent in part, by the same teachers that give the academic courses in mathematics.

It is the opinion in twenty-three per cent of the schools that there should be no difference, except in courses in methods, in the instruction in mathematics offered to students preparing to teach and to other students. The remaining schools take the

point of view that in courses for students preparing to teach, more attention should be paid to the aims in teaching mathematics, to methods of explanation and orderly presentation, and to the historical development and economic importance of the subject.

III. *Methods of Instruction and Branches of Study.*

Courses offered. The courses of study in sixty-four schools were obtained either from answers to questionnaires or from the catalogs of the schools. The following table shows the different courses given, the number of schools offering each course, and the average number of hours given to each course:

Subject.	*Number of Schools.*	*Average Number of Hours.*
Arithmetic	all	100
Elementary Algebra	all	171
Plane Geometry	all	143
Advanced Algebra	9	108
Solid Geometry	18	72
Methods of Teaching Mathematics	32	63
Plane Trigonometry	40	77
Spherical Trigonometry	4	80
Analytics	25	96
Calculus	23	87
Theory of Equations	3	52
Differential Equations	1	48
Surveying	11	57
Analytical Mechanics	1	48
History of Mathematics	8	70

Required and elective work. High school graduates, taking a two year course in a normal school, are required to review arithmetic and, in some schools, algebra and geometry. Students who enter the normal school from the eighth grade are required to take courses in arithmetic, algebra, and geometry. If more advanced courses in mathematics are offered, they are as a rule elective. The number of students electing mathematics is small in most schools, mathematics being elected usually by those who desire to secure advanced standing in college or to teach the subject in high school. No elective work is offered in thirty-two per cent of the schools reporting on this question.

Methods of conducting classes. Recitations by the students, supplemented by an occasional lecture, is the practically universal

method. In nearly all cases a text is used as the basis of a course, the text being supplemented at the pleasure of the instructor.

Practice teaching. One of the most important parts of the professional training of a student in a normal school is the practice teaching under supervision. In the schools reporting, the average number of class periods of practice teaching in mathematics which it is possible for a student making a specialty of mathematics to do, is eighty. In seventy-six per cent of the schools all students are required to do some practice teaching in mathematics, and the average number of class periods required is fifty-four. This teaching is always under the direct supervision of a critic teacher. In fifty-one per cent of the schools reporting the head of the department of mathematics is said to exercise some supervision over the practice teaching, but in some of these schools the supervision is very slight. Such supervision seems to the committee to be very desirable in order to unify the work in mathematics throughout the school, to make the work of the training school more efficient, and to keep the teachers of mathematics in the normal school in touch with elementary school work.

Correlation. Of the schools reporting, twelve per cent say that no attempt is made to correlate the different mathematical subjects. Thirty-eight per cent are attempting to make some systematic correlation. The remainder attempt some correlation, but nothing systematic. Twelve per cent of the schools reporting on the question think it advisable to eliminate entirely the traditional boundaries between arithmetic, algebra, and geometry; nineteen per cent think these boundaries should be eliminated to a large extent; seven per cent not at all. Other schools suggest methods by which related topics in the different subjects may be correlated.

Sixty-nine per cent of the schools report some attempts at correlating mathematics with other subjects, usually with the sciences, but close correlation is made, probably, in but few schools. The replies to the questionnaire indicate that it is the general opinion that in arithmetic the larger part of the problems in the lower grades and some of the problems in the upper grades should be taken from the other subjects that the pupils are pursuing and from the pupil's environment.

Much more is now being done in the normal schools in the way of using algebra and geometry as well as arithmetic to solve

problems taken from other school subjects and from the experience of the pupils than has ever been done before. Some of these problems are taken from texts, which furnish more such problems than formerly, some are obtained from published lists and from periodicals, and many more are made by the teachers themselves. Some of the teachers in normal schools have been active in arousing interest in applied problems. The great difficulty is to find applied problems that are of real interest to a large number of the students.

Causes of failure in mathematics. The question was asked, What causes operate to produce failures in mathematics in normal schools that do not operate in other subjects? About one fourth of the answers say none. Other answers say that too much time is devoted to other subjects; that we have poor methods of instruction and poor elementary training; that too much is attempted; that the subject, as it has been taught, lacks interest.

Libraries and other equipment. The libraries of the normal schools are generally well supplied with works on elementary mathematics, and on the history and the teaching of mathematics. The departments are also supplied with apparatus necessary for illustrative work in teaching weights and measures, and geometrical models for use in teaching mensuration and solid geometry.

IV. *Examinations.*

Thirty-seven per cent of the schools reporting say that examinations are held at the option of the instructor. In such cases the examinations are given at intervals of from two to six weeks at the completion of important topics. The rule in the remaining schools is to hold examinations at the end of each term or semester. In one school no examinations are given. The examinations are written in eighty-three per cent of the schools; in the remainder, both written and oral. In forty-one per cent of the schools the examination periods are from forty to fifty minutes; in forty-six per cent from one to two hours; in thirteen per cent from three to four hours.

The principal objects of the examinations are stated to be to test the knowledge of the students, to furnish a test of the teaching, to give unity to the subject, and to secure a review. In five per cent of the schools the grades depend entirely upon the examinations and in two per cent not at all. In twenty per cent, the examinations count for one half in determining grades;

in forty-four per cent for one third; and in twenty-nine per cent for less than one third. In forty-four per cent of the schools there is a tendency to give less consideration to written examinations given at stated intervals, and in forty-five per cent there is a tendency toward abolishing them.

In three states the governing board of the normal schools or the state department of education conducts annual examinations, which in some cases determine promotion and graduation.

Modern tendencies in the teaching of mathematics. The committee asked for opinions concerning some recent movements to improve the teaching of elementary mathematics. While it is probable that not all of these recommendations are carried out in the schools from which they come, they are valuable at least as indicating present tendencies.

Reforms in initial instruction. One question asked for recommendations for improving the initial instruction in arithmetic, algebra, and geometry. The following are the principal recommendations made:

About eighteen per cent of the answers recommend that the study of arithmetic be begun later. There should be more objective work, especially in the lower grades. The work should be less mechanical. There should be drill on the fundamental operations until the pupils have a much higher degree of speed and accuracy than at present.

The single recommendation for teaching algebra that comes from almost all schools is that algebra be more closely connected with arithmetic, so that the transition from arithmetic to algebra may be a simpler and more natural one. To accomplish this let the literal notation be introduced not later than the seventh grade and used freely in the eighth grade. Furthermore, to make algebra more interesting and useful, let it be used in solving real problems.

The answers show a general tendency toward making geometry less formal in the beginning. Attempts are made by the use of construction work and other methods of illustration to base the elementary concepts more completely upon the experiences of the pupils. Numerical and other applied problems are used to give the subject more meaning.

Reorganization of subject-matter. Fifty-one schools sent replies to the question, What traditional topics should be omitted from the course of study in arithmetic, algebra, and geometry? In the case of arithmetic, the general recommendations are to omit

all obsolete and purely technical topics, and unduly complicated problems. The number of topics which one or more schools recommend for omission is large. Thirteen schools recommend the omission of cube root except by factoring; fifteen, the omission of true discount; nine, the highest common factor by the Euclidian method; six, partnership and compound proportion; five, partial payments and progressions; four, compound and annual interest, much of percentage, and complicated problems in fractions; three, bank discount and longitude and time. Other topics are listed for omission by one or more schools. Although a very small per cent of the schools would omit all of the topics just named, the list possesses some interest in that it shows how many of the traditional topics are being removed from the course. There are further suggestions that indicate a somewhat general tendency to abridge the above topics when they are not omitted.

It is generally recommended that the work in algebra be less formal; that we omit or postpone until late in the course complicated multiplications and divisions of polynomials, complicated problems in factoring, fractions, and radicals, and highest common factor by division. The ideas of a function and of variation should be introduced early. A large number of applied problems should be given throughout the course.

A number of schools recommend that limits, variables, and incommensurables be omitted from elementary geometry. Other schools think these topics should be retained, but that in discussing them only illustrations should be used, and that no proofs should be attempted. In some schools it is thought that with students of the grade of maturity of those in normal schools it is profitable to discuss the formal proofs of some of the elementary theorems in the above topics. There is general agreement that the proofs of some of the more difficult theorems in plane geometry may be omitted.

Laboratory work. Twenty-six per cent of the schools reporting do some laboratory work in mensuration; fifteen per cent do field work in trigonometry or surveying; thirty-three per cent more make some application of the mathematics either in laboratory work or in applied problems. The results from laboratory work are generally thought to be good, but not in all cases.

Experiments in teaching mathematics. About fourteen per cent of all schools reporting to this committee have made some experiments in teaching mathematics. These were in the main

experiments to determine better methods of teaching arithmetic. One of these, for example, was an experiment to determine the efficiency of daily drills in the fundamental operations and to determine the effects of such drills upon the reasoning power. It is encouraging to know that a number of teachers of mathematics in normal schools are undertaking in a scientific way to obtain data concerning improvements in teaching mathematics.

Possible dangers in recent movements. The schools were asked to state what dangers they see, if any, in recent movements to make secondary mathematics more intuitive, useful, and attractive. The answers show a wide range of opinion, as might be expected. Forty-four per cent of the answers say that no danger is seen. Other answers say that the movements in question have caused inefficient teaching; that drill is neglected; that the disciplinary value of the subject is lost; and that there results superficial, unrelated knowledge.

REPORT OF THE SUBCOMMITTEE ON PRIVATE NORMAL SCHOOLS.

The great majority of the private normal schools conduct their own preparatory departments and hence have no specific entrance requirements. They generally receive students of all grades and fit them for entrance into such courses as they sustain. Applicants for advanced standings are usually allowed credits on high school diplomas, or on recommendations from former instructors, though students coming from high schools are very often found deficient in the most elementary parts of mathematics. It is recommended that in the lower schools persistent drills be given in the fundamental operations of arithmetic, so that students may perform these operations, not only with facility, but with absolute certainty as to the correctness of their results and may be able to prove the accuracy of their answers.

Graduates from private normal schools usually teach in the public schools of the country. There seems to be no uniformity whatever in the credits given by the higher institutions of learning for mathematics covered in private normal schools. Each one of these schools stands on its own merits and has its own reputation. Credits usually depend upon the knowledge of the examining boards of the universities from which advanced standing is asked, of the character of the work done in the school from whence the applicant comes. The state universities of the various states in which the private normal schools are located usually give full credit for all the work done in mathematics in

the schools of their own state. The comparison of the widely differing reports would seem to indicate that about thirty per cent of the graduates of the private normal schools in this country enter universities and technical schools for the purpose of doing more advanced work; while about fifty per cent of the graduates teach for five years or more.

Contrary to the usually accepted opinion, it is probably true that it is not the chief object of the so-called private normal schools to prepare students for teaching. The majority of the students later go into business, and a considerable number into technical work. Consequently the utilitarian side of the study of mathematics is probably the phase that is chiefly emphasized. Special courses for students bearing upon the history of and theory of teaching mathematics are rarely if ever offered.

There appears to be a growing tendency to give frequent tests or examinations. These are usually written and required at various intervals. Some schools give tests as often as once a fortnight, others once a month, and still others not oftener than once in from six to ten weeks. Final grades do not usually depend wholly upon the result of these tests. Perhaps a weight of about fifty per cent is given to them, and about fifty per cent to the record made in class.

Very little of the instruction is given in the form of lectures to the class, recitations on the part of the pupils being the well-nigh universal rule. The recitation periods are very generally one hour in length, five recitations per week. Classes are always sustained in arithmetic, the time required of the student depending upon his proficiency upon entering the school. From forty to sixty weeks are usually given to algebra, and very satisfactory courses are generally offered. These usually include college algebra. Usually about thirty-six weeks are given to plane surveying. Many of the schools which sustain four year courses require about six months' work in analytical geometry and perhaps the same time in the study of calculus, though, not infrequently, a course offered in the last named branch extends through an entire year.

In the foregoing it should be borne in mind that in all these branches there are five recitations per week, each an hour in length, and that the school year contains from forty-eight to fifty weeks without intermission. The greater number of the private normal schools divide the year into four terms, twelve

weeks each, with an intermission of but a day or two between terms.

We have found the replies received to the questions bearing upon methods and modern tendencies in the teaching of mathematics so meager that we are not able to formulate therefrom any conclusions as to the general opinion held by instructors.

REPORT OF SUBCOMMITTEE ON TEACHERS OF MATHEMATICS IN NORMAL SCHOOLS.

There are about twice as many men as women teaching mathematics in the normal schools of the United States. In the eastern part of the country, however, the women far outnumber the men.

The training of the teachers varies widely. About sixty per cent of the teachers have had high school training, fifty-five per cent have had normal school training, eighty per cent have had college training, and thirty-six per cent have done postgraduate work at the universities. The average training for the men is considerably higher than that of the women. There is a marked tendency toward the requiring of postgraduate work as a prerequisite for teaching mathematics in normal schools. Since the training of the teachers varies widely there is also a wide variation in the degrees held by the teachers. About one-third of the teachers have no earned degree; forty-two per cent have the bachelor's degree; eighteen per cent have the master's degree; and six per cent have the doctor's degree. The men who hold the higher degrees far outnumber the women.

The term of service in present position averages about seven and one half years and is practically the same for men as for women. Twenty-three per cent of all the teachers have served in their present position for ten or more years and fifty per cent have served five years or more.

The teachers in the normal schools have not contributed many books or articles to the literature of their field. This may be due in part to the fact that most of the teachers meet a large number of classes each week and consequently they have neither the time nor the energy necessary for authorship. There is a tendency to lighten the work of the teacher in the normal schools and this may result in a more productive scholarship in these schools. Practically all of the contributions made up to the present time have been by the men.

None of the schools make a practice of employing its under-

graduates as instructors and only a few of the schools so employ their graduates without further training.

Most of the teachers of mathematics would prescribe work through the calculus as the minimum academic preparation for teachers of mathematics. About fifteen per cent of the teachers would include more advanced courses as the minimum preparation.

A large per cent of the teachers express the opinion that in addition to the academic training the prospective teacher of mathematics should also be required to take a professional course including psychology, history of education, school management, and special methods in the courses that he is to teach.

About thirty per cent of the teachers express the belief that an experience of from one to five years in the graded schools and the high schools should be a prerequisite for normal school teaching.

A SECOND NOTE TO "GENETIC INSTRUCTION IN GEOMETRY."

By Eugene R. Smith,
The Polytechnic Preparatory School, Brooklyn, N. Y.

In the note to "Genetic Instruction in Geometry," School Science and Mathematics, January, 1912, the author has simply added to Professor Hart's article another illustration of the genetic method applied to class development. The "Genetic," "Heuristic," or "Syllabus" method (while not exactly the same in meaning, they are used interchangeably in this country) consists quite largely in just such class developments as Professor Blakslee has given here. Many teachers believe that such work can be done to most advantage if the pupil has not a book containing the full proof, but that does not change the character of such developments.

As for this particular construction, why not the following?

Teacher: How can a rectangle be constructed so its ratio to the given square shall be m to n?

Pupil: By cutting off a part on one side of the square so that it has the ratio m to n to the whole side, and erecting a perpendicular at this point.

Teacher: How can a square be constructed equivalent to this rectangle?

Pupil: By using the mean proportional between its sides as the side of the square.

Teacher: Then how could a square be constructed so that its ratio to a given square would be m to n?

Pupil: By constructing a rectangle having that ratio to the square by the method just explained, and then constructing a square equivalent to that rectangle.

AN EXPERIMENT IN THE ORGANIZATION AND TEACHING OF FIRST-YEAR ALGEBRA.[1]

By Walter S. Monroe,
University of Missouri, Columbia, Mo.

It is the purpose of this paper to set forth briefly the principles underlying the organization of a course in first-year algebra, to describe the organization of the course, and to indicate the results of trying it out in a class. The work described is the beginning of an attempt to work out in the University High School a course in mathematics which shall be in accord with the interests and needs of the pupils in the first year of the high school.

It is a fairly well-accepted educational principle that unless a pupil feels that there is some reason for studying a subject, that unless the pupil has a motive for studying the subject, our efforts to teach him that subject are practically fruitless. What the pupil wants to learn he studies and does not relax his efforts until he acquires it; what he does not want to learn he avoids and studies only with reluctance.

It is admitted, of course, that by means of frequent drill and numerous repetitions a considerable skill for doing specific things, for manipulating certain processes, can be developed in a class even when they feel little or no motive. But in these cases it seems extremely doubtful if the pupil has increased his total of effective knowledge.

This general educational principle is applicable to secondary mathematics. Before the pupil will really study mathematics, he must recognize some motive. He must feel that mathematics will satisfy some need which he has. This motive may be one of several possible ones. However, I wish to state as my first thesis: *The only satisfactory motive for the study of mathematics in the first year of the high school must be based on or connected with a feeling that the subject-matter of mathematics is worth while or valuable in itself; that it is useful, good for something.*

In making this statement I recognize that it is possible to interpret it to mean either that the motive for the study of first year algebra must be based on its practical utility, or that the motive must be based on an appreciation of the subject as a science; and also that I have used terms, some of which have no

[1] From a paper read before the Mathematics Section of the Missouri Society of Teachers of Mathematics and Science at Columbia, Mo., May 6, 1911.

recognized standard meaning. In regard to the interpretation of the statement, I may say, at this point, that my position is neither of the extremes indicated. The practical utility of mathematics represents a very narrow aim; the study of mathematics as a science is not suited to pupils in the first year of the high school. In order to convey more definitely my meaning, I propose to define what I mean by (a) subject-matter of algebra, (b) worth while or valuable, and (c) how a motive based on this feeling of value may be created for the study of what I mean by subject-matter.

What is to be presented to the pupil as the subject-matter of a course should depend upon the goal we are aiming at. In other words, the aim or function of elementary algebra should determine, to a very large extent, the subject-matter of elementary algebra. Certainly in life outside the schoolroom, the aim or function determines the tools which we use. For instance, if you wish to cut your lawn, you do not attempt to use a hatchet or if you are splitting kindling you do not use the lawn mower.

Although there is considerable difference of opinion as to what we are, or rather should be, aiming at in elementary algebra, some of our most prominent mathematicians, both in this country and in Europe, have urged in very recent years, an aim for elementary algebra which appeals to me as being the big thing which we should be aiming at; the aim or function to which all other functions should be and are subsidiary.

These mathematicians urge, though in slightly different words, that the *aim or function of elementary algebra is to make the pupil willing and able to discover and study the relations which exist between varying quantities and the means of controlling these relations.*[2]

It may seem to you that this aim is very indefinite, or possibly it may seem that it is not practicable. For the relations which exist between the quantitative factors of our experience are various and often complicated; they seldom can be expressed by means of equations or algebraic expressions which the pupil in the first year of the high school can manipulate; often the relations are such that the result is indeterminate or indefinite and thus answers such as we are accustomed to require cannot be obtained.

---

[2]For the agreement of this with the general aim of education, see Münsterberg: Psychology and the Teacher, especially Chapter VIII.

This is all very true but there are a few relations which are simple, and several other which are combinations of simple relations, and still others which approximate simple relations. And furthermore, these relations occur in a considerable variety of connections. Take the example of one quantity varying directly as another. This is found in uniform motion where the distance varies directly as the time, or directly as the velocity. Work varies directly as the distance. Fluid pressure varies directly as the depth. The force of gravity below the surface of the earth varies directly as the distance from the center. Simple inverse variation occurs in an equally large number of situations. We find also variation both direct and inverse as the square and even cube of the independent variable. Then we have combinations of these as in the case of a body thrown upward, or the relation between the surface of a cylinder and its radius when the volume is constant. And finally, the trigonometric relations, which represent another type of variation, can be studied. It is needless to say that they occur in many situations.

Following our aim we should take up these various relations and study them in the various situations in which they occur. These situations we call *problems*.

Each individual desires to determine and control the relations which exist between the factors of his experience, that is, each individual wishes to understand his environment. Psychologists tell us that the first year pupil of the high school especially wants to understand his environment, wants to know the *why* of things, how things are naturally connected. That is, he is interested in what we have called a problem. Thus the pupil has a strong natural motive for the study of such problems at this particular time in this life. But in the study of these situations, these problems, he will want, he will feel the need of tools.

The tools for the control or study of these problems are what we are accustomed to call algebra. They are the symbolism (representing quantities by letters and operations by various devices such as a^2, $\sqrt{6}$, etc.), the equation and the operations necessary for its solution (clearing of fractions, completing the square, factoring, etc.), graphical methods and devices, etc. Since these symbols and processes are needed for the control of problems which the pupil naturally feels to be valuable, he possesses a motive for learning them.

But in order that this motive may be active, the problem must be given to the pupil first and then the symbolism and processes of

algebra offered to him as tools for the understanding and control of these problems.

Another conclusion which follows from our point of view is in regard to the organization of the subject-matter which we have indicated. We are to present to him situations (problems) involving the relations which he feels a need of understanding. The problem is to be given to him first, and then the symbolism and processes of algebra are to be offered to him as tools for understanding and controlling these problems. For instance, a problem which results in a quadratic equation is to be given to the pupil before he has studied quadratic equations. After and only after the pupil has stated the problems and finds that he has an equation which he cannot solve by the methods which he has been using does he feel a need of knowing how to solve a quadratic equation.

Furthermore, other problems resulting in quadratic equations should be solved by the pupil before he is given drill in solving quadratic equations. Then quadratic equations may be presented simply for drill in a process which he has already found he needs if he is to understand and control certain problems which he considers valuable. As a rule the amount of drill required will be much less than we are accustomed to require.

This is exactly the reverse of our traditional procedure. We usually spend a number of recitations drilling the class upon processes and symbolism and then a few recitations in applying them in problems. But if a pupil does not realize what a given process is good for, it is hard to see how he can have a legitimate direct motive for studying it. And an appreciation of the usefulness of a process can only be acquired by the use of that process. Therefore if problems are to furnish motive for the study of processes, they must *precede* and *not follow* the drill on the processes.

Where are our problems to come from, and what shall be our basis of selection? If we deliberately set out to find problems for the purpose of building up a course, we may enter upon the search with enthusiasm and confidence. However, the examination of our present texts reveals the fact that the types of problems which we have are not numerous and that many of the problems now in our texts should be ruled out. The total number of problems in the texts of to-day which are not open to severe criticism does not exceed a few hundred; if we except duplicates the number is considerably less than fifty.

In the exposition of the aim or function of elementary algebra, the source and type of problems were suggested. The problems are to be situations close to the life of the pupil in which simple relations occur. This is to be our test for a problem. We are to search for problems in those situations whose quantitative factors are connected by relations which are appropriate for the pupil in the first year of the high school.

Problems selected or made according to the criterion do not differ essentially from several of the problems which we find in the texts of the present day. But all problems which involve relations which are not natural relations or involve situations which could not possibly arise would be emphatically ruled out. The question as to whether a particular problem is suitable or not is often a delicate question which I find difficult to decide.

Following the criteria just mentioned, I collected a list of about 500 problems about half of which were taken from texts on elementary algebra and the other half were made from suggestions received from various sources. I might say by way of explanation that this is the result of several months' work and in order to find this number, which may seem small to you, I was compelled to invade several fields which are not usually thought of as suitable for any high school pupil. At the time I completed the list I felt that I had exhausted all the possibilities which were known to me at that time. Since that time, a matter of four or five months, I have found a few but not many more suitable problems.

This total number includes, of course, several problems which are essentially duplicates in the sense that they involve the same sort of situation but different quantities. This is, I think, desirable, for thus the pupil has an opportunity to become acquainted with the situation before he leaves it. He needs some practice in order to handle it skillfully.

This list of problems together with the algebraic tools needed for their control were organized into a course sufficient for the first year of the high school. The order was, *first* the problem, *second* the process, *third* more problems, *fourth*, if needed, drill upon the process, and *last* problems of greater difficulty. In some cases sufficient drill on the process was obtained through the solution of problems. This was true in graphical work.

The material of the course was grouped in six chapters. No great importance should be attached to this particular division since it is not an essential part of the scheme. The order of the

chapters was, however, rather carefully thought out. This order seems to be demanded if processes are to be used when needed.

The first chapter of the course is introductory and begins with percentage problems. The student is first asked to solve problems involving the various cases by the usual methods of arithmetic. Problems whose arithmetical solution is rather difficult are given to the pupil. The equation is then offered him as a means of solving these problems and as a way of stating the relation existing between the quantities (base, rate, and percentage). The transition from arithmetic is slow and is never forced. Necessary explanations, definitions, and drill on the equation are given only as they are needed by the pupil. Besides percentage problems there are included in this chapter lever problems, problems of uniform motion, partnership, and a few miscellaneous problems. In no case does the resulting equation necessitate transposition nor do negative numbers occur.

Chapter II is limited to problems resulting in simple equations. The operations introduced are removal of parentheses, transposition, negative numbers and operations with them. The problems of this chapter are taken from levers, uniform motion (linear and circular), changing thermometer readings from Fahrenheit to Centigrade, specific gravity, and mixtures.

In chapter III the quadratic equation is introduced together with the multiplication of binomials, arithmetical square root, factoring (in simple cases), exponents and radicals for squares and square roots. The problems are taken from mensuration, motions at right angles, and errors in measurements.

These three chapters form half of the text. With the exception of simultaneous equations they include practically all that is usually taught, which is required for the solution of the problems given in the first year of the high school. It may be interesting to know that they were easily completed by Christmas.

The fourth chapter takes up fractional equations and clearing of fractions. The problems are taken from the determination of unknown heights and distances by means of the ratios of similar triangles, mensuration, and division of labor. In addition to this the solution of triangles by means of drawing to scale when angles are given as data (protractors are used) are taken up and problems introduced from mechanics, composition and resolution of forces and velocities, work, energy, momentum, etc. Types of variation are studied under the name of variation. For example, the law of attraction above and below the surface of

the earth, the relation between the length of a pendulum and the time of vibration, etc., are studied.

Chapter V is devoted largely to the graphical solution of problems which the pupil cannot readily solve otherwise. The graph is not presented as a means of solving equations but as a method of solving problems. In this chapter the pupil studies such problems as the relation between the time of day and the temperature, statistical problems, maximum and minimum problems, areas of irregular tracts by means of cross section paper, and the graphical representation of time tables.

The last chapter consists of five pages devoted to simultaneous equations. No new types of problems are given here.

As I stated in the beginning I have used this course as a text in a class this year. The class was an average first-year class. Most of the members of the class had never studied algebra. In addition to this the course has been used for a portion of the year in three other classes by inexperienced teachers under conditions not as favorable as I had.

The things aimed at are such that they cannot be measured in terms of definite units and hence the results cannot be stated in definite form. But I may say that in comparison with other classes I have taught either in mathematics or science the interest of the class has been unusual. I feel that I am conservative in saying that it excels that of any other class in mathematics which I have taught. They know how and can solve a large number of problems, many of them difficult. Their attitude toward a problem is not that it is something which they are merely to solve but rather that it is an opportunity for them to study certain relations and ways of handling these relations and to learn a method of attack. In addition to this they have a fair knowledge of the operations and processes of elementary algebra. They are able to attack a problem intelligently and have learned to know when they are right. They know how to determine whether their results are reliable or not.

The work in the other classes, although it has not been carried on long enough to warrant as definite statement, has been successful.

I am well aware that this must be considered as a first attempt and that the whole thing is yet quite crude. Much remains to be done before a definite stand can be taken. However, I feel that the ideas upon which the course is based are sound and that when the course is properly worked out a distinct advance in the organization of the subject-matter of elementary algebra will have been made.

PROBLEM DEPARTMENT.

By E. L. Brown,

Principal North Side High School, Denver, Colo.

Readers of this magazine are invited to send solutions of the problems in which they are interested. Problems and solutions will be duly credited to their authors. Address all communications to E. L. Brown, 3435 Alcott Street, Denver, Colo.

Algebra.

270. *Proposed by Letitia Odell, Denver, Colo.*

Factor $x^2-8xy+15y^2+2x-4y-3$.

I. *Solution by C. A. Perrigo, Dodge, Neb., and E. G. Berger, St. Paul, Minn.*

If the expression can be factored, its form shows it to be the product of two polynomials of the first degree. Also, the expression $x^2-8xy+15y^2$ must be the product of the terms of the first degree in these polynomials.

By inspection $x^2-8xy+15y^2 \equiv (x-5y)(x-3y.)$ (1.)

Hence if the given expression is composite there must be two numbers p and q such that $x^2-8xy+15y^2+2x-4y-3 \equiv (x-5y+p)(x-3y+q)$ (2.)

$$\equiv x^2-8xy+15y^2+(p+q)x-(3p+5q)y+pq. \quad (3.)$$

If (3) is an identity, $2x=(p+q)x$ and $-4y=-(3p+5q)y$ and $pq=-3$.

Therefore, $2=p+q$, $4=3p+5q$ and $pq=-3$.

Solving we obtain $p=3$ and $q=-1$, which values prove in $pq=-3$.

Substituting in (2.) we obtain

$$x^2-8xy+15y^2+2x-4y-3=(x-5y+3)(x-3y-1).$$

II. *Solution by A. M. Harding, Fayetteville, Ark., and H. H. Seidell, St. Louis, Mo.*

By partially extracting the square root of the given expression, it can be written

$$(x-4y+1)^2-(y-2)^2=(x-3y-1)(x-5y+3).$$

III. *Solution by T. M. Blakslee, Ames, Iowa, and Richard Morris, New Brunswick, N. J.*

Write the expression in the form

$$x^2-(8y-2)x+15y^2-4y-3.$$

Equate this to zero and solve the quadratic for x.

Then $x=5y-3$ or $3y+1$.

$\therefore$ the given expression $= (x-5y+3)(x-3y-1)$.

271. *Proposed by H. E. Trefethen, Waterville, Me.*

If $y^2-yx+1=0$, express y, by means of indeterminate coefficients, in a series of monomials (1) in ascending powers of x; (2) also in descending powers of x.

Solution by W. J. Risley, Decatur, Ill., and the Proposer.

Solving the given equation, $y=x/2\pm\sqrt{x^2/4-1}$. Hence

$y=x/2\pm\sqrt{-1}\ \sqrt{1-x^2/4}$.....(1) or $y=x(1\pm\sqrt{1-4/x^2})/2$ ..... (2)

Put $z=(x/2)^2$, thus $z^{-1}=(2/x)^2$, and $\pm\sqrt{1-x^2/4}$

or $\pm\sqrt{1-4/x^2}=\pm\sqrt{1-z^{\pm 1}}$.

Now put $\pm\sqrt{1-z^{\pm 1}} = A+Bz^{\pm 1}+Cz^{\pm 2}+Dz^{\pm 3}+Ez^{\pm 4}+$ etc.

Squaring, $1-z^{\pm 1} = A^2+2ABz^{\pm 1}+(B^2+2AC)z^{\pm 2}+2(AD+BC)z^{\pm 3}$
$+(C^2+2AE+2BD)z^{\pm 4}+$ etc.

Whence $A=\pm 1$, $B=\mp 1/2$, $C=\mp 1/2\,.\,4$, $D=\mp 3/2\,.\,4\,.\,6$,
$E=\mp 3\,.\,5/2\,.\,4\,.\,6\,.\,8$, etc.

Hence $$y=x/2\pm i\left[1-\frac{1}{2}\frac{x^2}{2^2}-\frac{1}{2.4}\frac{x^4}{2^4}-\frac{1.3}{2.4.6}\frac{x^6}{2^6}-\cdots\cdots-\frac{1.3.5\cdots\cdots(2r-3)}{\lfloor r}\frac{x^{2r}}{2^{2r}}\right]\cdots\cdots \quad (1)$$

Also $$y=\frac{x}{2}\left[1\pm\left(1-\frac{1}{2}\frac{2^2}{x^2}-\frac{1}{2.4}\frac{2^4}{x^4}-\frac{1.3}{2.4.6}\frac{2^6}{x^6}-\cdots\cdots-\frac{1.3.5\cdots\cdots(2r-3)}{2.4.6.8\cdots\cdots 2r}\frac{2^{2r}}{x^{2r}}\right)\right]\cdots\cdots \quad (2),$$

$=x(1/2\pm 1/2)\mp x^{-1}\mp x^{-3}\mp 2x^{-5}\mp 5x^{-7}\mp\ldots\ldots\mp 2\,.\,6\,.\,10\ldots 2(2r-3)/\lfloor r\,x^{2r-1}$, all the coefficients being integers.

272. *Selected.*

Let F and F' denote integral functions, and M/N and M'/N' proper fractions. If $F+M/N\equiv F'+M'/N'$, then $F\equiv F'$ and $M/N\equiv M'/N'$.

Solution by A. M. Harding, Fayetteville, Ark., and Nelson L. Roray, Metuchen, N. J.

Suppose $F\neq F'$ and let $F=F'+F''$, where F'' is an integral function.
Then $F'+F''+M/N=F'+M'/N'$,
that is $F''=M'/N'-M/N$, a proper fraction.
This is absurd unless $M/N=M'/N'$ and $F''=0$.
In this case $F=F'$.

273. *Example 71, p. 34, "A Course of Plane Geometry for Advanced Students, Part I," by Clement V. Durell.*

Given the incenter, circumcenter, and one excenter of a triangle; construct it.

Solution by I. L. Winckler, Cleveland, O., and J. G. Gwartney, Mountain View, Cal.

Let ABC be the required triangle. The line passing through O the incenter and O′ the excenter bisects the angle BAC. O″ is the circumcenter and K is the midpoint of OO′.

OBO′ and OCO′ are right angles, since the sides of each bisect supplementary adjacent angles. Hence KB=KC and K, being in the perpendicular bisector of BC and also in the bisector of the angle A, is on the circumcircle.

Therefore to construct the triangle, describe about O″ with radius =O″K the circumcircle ABC, and on OO′ as diameter the circle OBO′C. ABC is the required triangle.

274. *Proposed by John Gaub, Ithaca, N. Y.*

A round hole one foot in diameter is cut through a sphere 20 inches in diameter. Find volume of part remaining.

Remark: The axis of the hole is to pass through center of the sphere.—Ed.

I. *Solution by J. E. Helman, Conneaut, O., and Eugene M. Dow, Brighton, Mass.*

The part removed consists of (1) a right circular cylinder having a radius of six inches and an altitude of sixteen inches, and (2) of two

equal spherical segments of one base and having an altitude of two inches.

Vol. of sphere $=4000\pi/3$ cu. in.

Vol. of cylinder $=576\pi$.

Vol. of one spherical segment $=112\pi/3$.

$\therefore$ Vol. remaining $=4000\pi/3 - (576\pi + 224\pi/3) = 2048\pi/3$.

II. *Solution by G. Sergent, San Mateo, Cal.*

A plane passing through axis of hole will intersect the portion remaining in two equal circular segments. Let AMB be one of these segments, AB the chord and M the midpoint of the corresponding arc AB.

Use theorem: The solid generated by a circular segment revolving about a diameter exterior to it, is equivalent to one sixth of a cylinder whose radius is the chord of the segment and whose altitude is the projection of that chord on the axis.

The vol. generated by the segment AMB revolving about axis of hole equals

$$\tfrac{1}{6}\pi AB^3 \cdot AB = \tfrac{1}{6}\pi AB^3$$

We easily find $AB=16$.

$\therefore V = \tfrac{1}{6}\pi AB^3 = 2048\pi/3$.

275. *Proposed by H. E. Trefethen, Waterville, Me.*

Divide the triangle whose sides are 7, 15, 20 into two equivalent parts by a radius of the circumcircle.

Solution by A. M. Harding, Fayetteville, Ark., and L. R. Perkins, Franklin, Mass.

$AB=20$, $BC=7$, $CA=15$

Area $= K = \sqrt{s(s-a)(s-b)(s-c)} = 42$

Radius of circumcircle is $SA = R = \dfrac{abc}{4K} = \dfrac{25}{2}$.

It can be easily shown that the perpendiculars from S upon AB and CA are respectively $\dfrac{15}{2}$ and 10.

Draw a radius of circumcircle cutting AB at B′ and AC at C′ and suppose this to be the required radius.

Let $AB'=c'$ and $AC'=b'$.

Area $\triangle SAC' = \tfrac{1}{2}AC' \times 10 = 5b'$.

Area $\triangle SAB' = \tfrac{1}{2}AB' \times \dfrac{15}{2} = \dfrac{15c'}{4}$.

$\therefore \triangle AB'C' = 5b' - \dfrac{15c'}{4} = \tfrac{1}{2}K = 21$;

i. e. $20b' - 15c' = 84$.

Now $\dfrac{\triangle AB'C'}{\triangle ABC} = \dfrac{AB' \times AC'}{AB \times AC} = \tfrac{1}{2}$ $\therefore \dfrac{b'c'}{300} = \tfrac{1}{2}$

From these equations we find

$b' = AC' = \dfrac{3}{10}(\sqrt{1299}+7) = 12.9123$ nearly

$c' = AB' = \dfrac{4}{10}(\sqrt{1299}-7) = 11.6164$ "

N. B. To construct a line $=\sqrt{1299}$ geometrically it is only necessary to form a right triangle whose legs are $12\sqrt{3}$ and $17\sqrt{3}$.

Then the hyp. $=\sqrt{1299}$.

CREDIT FOR SOLUTIONS RECEIVED.

259. W. T. Greenstreet, Jacob P. Sauter, Florence Winslow. (3)
265. Lester F. Weeks. (1)
267. G. Sergent. (1)
268. G. Sergent. (1)
270. E. G. Berger, T. M. Blakslee, C. D. Donaldson, Eugene M. Dow, John M. Gallagher (two solutions), J. G. Gwartney, A. M. Harding, Horace J. Hedges, J. E. Helman, G. I. Hopkins, Richard Morris, T. R. Parker, C. A. Perrigo, L. R. Perkins, T. E. Peters, W. J. Risley (two solutions), Nelson L. Roray, Jacob P. Sauter, H. H. Seidell, Lester F. Weeks, I. L. Winckler. (23)
271. L. R. Perkins, W. J. Risley, H. H. Seidell, H. E. Trefethen. (4)
272. A. M. Harding, H. G. McCann, Nelson L. Roray. (3)
273. J. G. Gwartney, A. M. Harding, L. R. Perkins, C. A. Perrigo, Nelson L. Roray, G. Sergent, H. E. Trefethen, I. L. Winckler. (8)
274. T. M. Blakslee, Eugene M. Dow, J. G. Gwartney (two solutions), A. M. Harding, J. E. Helman, H. G. McCann, Richard Morris, L. R. Perkins, C. A. Perrigo, W. J. Risley, Nelson L. Roray, H. H. Seidell, G. Sergent, Lester F. Weeks, I. L. Winckler. (16)
275. A. M. Harding, L. R. Perkins, Nelson L. Roray, H. E. Trefethen, I. L. Winckler, (5)

Total number of solutions, (65).

PROBLEMS FOR SOLUTION.

Algebra.

287. *Hawkes' Advanced Algebra, p. 79, Ex. 45.*

Solve and check:

$$x^{\frac{1}{3}} + \frac{41x^{\frac{1}{6}}}{x} = \frac{97}{x^{\frac{1}{6}}} + x^{\frac{5}{6}}.$$

288. *Proposed by Nelson L. Roray, Metuchen, N. J.*

One night three men, A, B, and C, stole a bag of apples and hid them in a barn over night intending to meet in the morning to divide them equally. Some time before morning A went to the barn, divided the apples into three equal shares and had one apple too many, which he threw away. A took one share and put the others back into the bag. Soon after, B came and did exactly as A had done. Then came C, who repeated what A and B had done before him. In the morning the three met saying nothing of what they had done during the night. The remaining apples were divided into three equal shares with still one apple too many. How many apples were there in the bag at the beginning?

Geometry.

289. *Proposed by L. R. Perkins, Franklin, Mass.*

Without employing proportional lines, construct a triangle given: c, B, $b-a$, where $b>a$.

290. *Proposed by Franklin T. Jones, Cleveland, O.*

If the side of a regular tetrahedron is a find the radii of the inscribed and circumscribed spheres.

291. *Proposed by Editor.*

If through the vertices of any inscribed polygon tangents are drawn forming a circumscribed polygon, the continued product of the perpendiculars from any point in the circle on the sides of the inscribed polygon is equal to the continued product of the perpendiculars from the same point on the sides of the circumscribed polygon.

SCIENCE QUESTIONS.

By Franklin T. Jones,
University School, Cleveland, Ohio.

Our readers are invited to propose questions for solution—scientific or pedagogical—and to answer the questions proposed by others or by themselves. Kindly address all communications to Franklin T. Jones, University School, Cleveland, Ohio.

Questions and Problems for Solution.
Answer serially numbered questions.

Entrance Examination in Agriculture, Cornell, 1910.

For one-half unit credit answer the first six questions.
For one unit credit answer each of the ten questions.

I. a. Name the four most important breeds of dairy cattle.
b. Tell where each breed originated.
c. Give the characteristics by which each breed may be recognized.

II. Explain in detail what are the advantages of underdrainage.

III. Give the chief points to be observed in the production of sanitary market milk.

69. IV. How much nitrate of soda containing 15 per cent nitrogen, acid phosphate containing 16 per cent phosphoric acid, and muriate of potash containing 50 per cent potash, will be required to make the equivalent of a ton of 2 : 8 : 5 fertilizer?

V. What is meant by the term nutritive ratio, in calculating balanced rations?

VI. How should Bordeaux mixture be made? What is the purpose of each ingredient used?

VII. Describe the method of estimating the age of horses by the teeth.

VIII. What spray materials are used to control sucking insects? To control biting insects?

70. IX. A New York dairy farmer has 100 acres of fairly good land:
a. What crops should be grown on it for his purposes?
b. What acreage of each should be grown?
c. What rotation should be followed?

71. X. A man has plowed a strip 6½ rods wide with furrows 30 rods long. How many acres has he plowed? How man yturns has he made if the plow cuts 14 inches? How far has he traveled? How long did it take him if the team walked 2 miles per hour and if an average of 3 minutes was lost at each turn? How much did it cost him at the rate of 40 cents an hour for man and team?

Solutions and Answers.

65. *Proposed by Tom Anderson, Cleveland.*

If 5.23 gm. brass yield 0.0345 gm. $PbSO_4$, and, subsequently on electrolysis of filtrate, 0.0031 gm. PbO_2, what is the per cent of lead in the brass?

Solution by E. M. Dunn, Aledo, Ill.

The atomic weights used were adopted in 1904, with
O=16, Pb=206.9 S=32.06
Atomic weight of $PbSO_4$=302.96.
" " " PbO_2=238.9
206.9 ÷ 302.96 = .682
68.2% = per cent of lead in $PbSO_4$
206.9 ÷ 238.9 = .866

86.6% = per cent of lead in PbO_2
.0345 × .682 = .023529 weight of lead
.0031 × .866 = 0.026846 = weight of lead.
Weight of lead in brass .0262136
.0262136 ÷ 5.23 = .00501
.00501 = ½%, with an error that is so small that it could be neglected as I have not carried anything farther than three places in division.

67. *Proposed by C. A. Perrigo, Dodge, Neb.*

Find the equation, in terms of x and y, for an object projected into empty space with a velocity v and an angle α with the horizontal plane. Compute its time of flight and range.

Solution by the Proposer.

Distance traversed on X axis during t seconds would be $vt \cos \alpha$. Distance traversed on Y axis would be $vt \sin \alpha$, but gravity has caused it to fall during that time a distance $= \frac{1}{2}gt^2$. So actual distance traversed on Y axis would be $vt \sin \alpha - \frac{1}{2}gt^2$.

Then $x = vt \cos \alpha$ .....1 and
$y = vt \sin \alpha - \frac{1}{2}gt^2$.....2

from (1) $t = \dfrac{x}{v \cos \alpha}$ 3

Substituting in (2)

$$y = \frac{vx \sin \alpha}{v \cos \alpha} - \frac{gx^2}{2v^2 \cos^2 \alpha} \text{ .....4}$$

$$\text{or } y = x \tan \alpha - \frac{gx^2}{2v^2 \cos^2 \alpha} \text{ ..... 5}$$

which is the equation required.

To find time of flight $y = 0$ in equation (2)

$$\therefore 0 = vt \sin \alpha - \frac{gt^2}{2}, \quad t = \frac{2v \sin \alpha}{g} \text{ ..... 6}$$

To find the range $y = 0$ in equation (5)

$$\therefore 0 = x \tan \alpha - \frac{gx^2}{v^2 \cos^2 \alpha}, \quad x = \frac{2v^2 \cos \alpha \sin \alpha}{g}$$

$$\text{or } x = \frac{v^2 \sin 2\alpha}{g}$$

Wanted—Information.

What are *you* doing that is
different?
better than you have done before?
new?
old but producing good results?
helpful to the less experienced teacher?
unknown to the rest of us?

Write it up and send in to the Editor, or write out your question as to how to accomplish a given result, or tell of someone who is doing new and excellent things.

MINUTES OF THE EARTH SCIENCE SECTION, CENTRAL ASSOCIATION.

The eleventh annual meeting of the Earth Science Section of the Central Association of Science and Mathematics Teachers was held in Room 55, Lewis Institute, Chicago, December 1 and 2, 1911.

The meeting was called to order at 2 P. M., December 1, by the chairman, D. C. Ridgley of the State Normal University, Normal, Ill.

The chairman appointed the following committees:

Nominations, Mr. James H. Smith, Austin High School, Chicago; Mr. J. M. Large, Township High School, Joliet, Ill.; Mr. Charles E. Peet, Lewis Institute, Chicago.

Resolutions, Professor G. R. Mansfield, Northwestern University, Evanston, Ill.; Miss Smedley, Joliet, Ill.; Mr. W. P. Holt, Toledo, O.

The following papers were presented: "Some Geographic Influences in the Development of Alaska," U. S. Grant, Northwestern University.

Professor Grant gave a very interesting talk illustrated by stereopticon maps and views, many of the latter being colored, of the region of Prince William Sound, from Copper River Inlet to the Kenai Peninsula. He said in part: This is a district with a very irregular shore line formed by the sinking of a mountainous coast, leaving long bays extending far back into the land, and long, narrow peninsulas. It is surrounded on the north by the crescent shaped range of the Chugach mountains, which rise from one to two miles above the level of the sea, and so by stopping the westerly winds bring a heavy precipitation (90" and 130") a milder climate, and forms an abundance of glaciers at the heads of the long bays. The range shows the effect of much more extensive glaciation, many of the mountains being rounded at the top by the ice which passed over them, while others have sharp peaks which were nunataks of the surface of the glacier. The retreat of the great glacier has left numerous hanging valleys with waterfalls which are as yet almost unused as a source of power for electricity.

In these mountains may be found the tarns, lakelets which occupy depressions in old glacial valleys, and cirques at the heads of these valleys; where the drowning of the coast line has been carried far enough these cirques form peculiar horseshoe shaped bays.

This region was first discovered by Captain Cook and Vancouver about 1793-94 in their search for a northwest passage; later it was visited by both Russian and Spanish explorers, and many of the names given by Hidalgo still remain. Following the Spanish came the fur traders, but the region does not contain a large amount of animal life, only the lower slopes of the mountains being forested; the chief fur is that of the sea otter, now almost exhausted, a single pelt of which brings $1,000.

Canneries came next in the history of the development of this section, but as implements, workers, and their shelter and food were brought up by boat from San Francisco and they together with their output returned by boat to San Francisco at the end of the season, this did not tend to any permanent settlement.

In the wake of this came the mining excitement, now developed into an industry, and with the mines came the settlement and development of the district. There are two great mines and there were hundreds of prospects in this region; pictures were shown of the Bonanza Copper mine really a quarry—a mountain side from which copper is being taken out and conveyed by trains to the sea only half a mile away.

The city of Valdez, from a collection of houses has become almost a metropolis with government cable and telegraph lines and road. This is the point of landing for the overland trail from the interior and the transfer business and the exploitation of mines have built up the town; incidentally miners who come down from the interior to spend the winter are also exploited, and many of them "go broke" before spring. Valdez has electric power from a waterfall in a hanging valley; but coal cannot be obtained from the coal fields near at hand, because of the failure of development under governmental regulations, and when shipped in costs about nineteen dollars a ton.

The city of Valdez is built on an outwash plain of the rivers which drain the glaciers, and as these distributaries frequently change place during floods, the inhabitants have been obliged to build a wall around the land side of the place in order to prevent their real estate from being washed out to sea. Back of the city the overland trail leads for miles over the Valdez glaciers to the interior.

Professor Grant spoke of Alaska's possibilities—so far undeveloped, as a tourist country because of its scenic attractions; one glacier, the Columbia, being larger than all the glaciers of the Alps put together. Mention was made of the advances and retreat of this glacier, which were clearly shown by the slides; the ice front with its pinnacles was shown in many of the glaciers of College Sound, at whose head are two glaciers named respectively Yale and Harvard; down the length of the sound are a row of glaciers bearing the names of various women's colleges.

Views of Seward showed a fiord being filled in, with the town built on a large alluvial fan. The slope and drainage make this a healthful situation.

In conclusion Professor Grant spoke of the resources of this section, largely of course connected with the mines; agriculture being undeveloped, though potatoes and garden crops can be raised near Seward.

In the absence of Walter S. Tower of the University of Chicago, Professor Woodworth of Lewis Institute gave an interesting talk on Humidity.

The exercise was illustrated with lantern slides and many striking facts relating to humidity were brought out. A United States map was exhibited showing the percentage of relative humidity. It was pointed out that this same map was a very good vegetation map, though drawn without any reference to vegetation. Emphasis was placed on the fact that the peach and pine belt of the United States lay in a definite humidity belt.

Many interesting relationships between humidity and people were described, and illustrated by the lantern slides. It was shown that people living in a very moist or a very dry climate were small of stature, while the taller races live in a climate intermediate in relative humidity. It was shown how our steam-heated flats in cold weather "out-desert the desert," the humidity often being much less than in the Sahara. The unhealthfulness of such conditions was pointed out.

The second session was called to order at 10:30 by the chairman, Mr. Ridgley.

The committee on nominations reported its recommendations: Geo. R. Mansfield, Northwestern University, Chairman; W. E. Durstine, Cleveland, Ohio, Vice-Chairman; Miss Bertha Anderson, Whitewater, Wis., Secretary. These persons were duly elected.

The following paper was presented: "The Content and Purpose of the Second Half Year of High School Geography," by R. H. Whitbeck, Editor *Journal of Geography*, University of Wisconsin.

This paper together with an outline of the physical geography course at Lewis Institute will be published elsewhere.

Report of Committee on Fundamentals, W. E. Durstine, Chairman.

The report, consisting of an outline, was presented and briefly discussed by Miss Grace F. Ellis of Grand Rapids in the absence of the chairman. This printed report was furnished to members present. Copies may be obtained by addressing W. E. Durstine, Technical High School, Cleveland, Ohio. It was moved and carried that this report be adopted, and the committees continued and directed to plan both full-year and half-year courses.

Report of the Committee on the Value of Different Methods of Teaching Physiography, James H. Smith, Chairman. This report was accepted and will be presented elsewhere.

Lack of time prevented the presentation of a report on An Investigation of Results of Physiography Teaching, by Chas. E. Peet. Moved and carried that this report be published in *School Science and Mathematics*, so that discussion might be possible at another meeting.

Report of the Committee on Desirability of a General Science Course in First Year High School, W. P. Holt, Central High School, Toledo, Ohio, Chairman. Mr. Holt furnished members present with a list of questions to be answered on the subject. Members of the section who were not present should write Mr. Holt and get a list of these questions.

Report of Committee on Resolutions, Geo. R. Mansfield, Chairman.

The following resolutions were presented and adopted:

Resolved, That the thanks of the Earth Science Section be extended to Professor Grant, Professor Woodworth, and Professor Whitbeck for their interesting and instructive papers.

Whereas, In the opinion of the Earth Science Section of the Central Association of Science and Mathematics Teachers, no high school course is complete without some recognition of the importance of science in everyday life, and

Whereas, Little uniformity of opinion now exists as to the amount and character of science work that should properly be required in high school courses,

Resolved, That the Earth Science Section recommend to the other science sections the desirability of the appointment of a general committee of the sections to confer upon this matter, and be it

Resolved, That three members of the said section be appointed to represent said section on such a committee, and be it further

Resolved, That the Earth Science Section go on record as strongly in favor of a full year's course in Physiography with emphasis on human relations, and with double periods if possible.

GRACE F. ELLIS, Secretary.

D. C. RIDGLEY, Chairman.

MINUTES OF THE BIOLOGY SECTION OF CENTRAL ASSOCIATION OF SCIENCE AND MATHEMATICS TEACHERS.

This section was called to order by the chairman, Miss McClellan, at 1:30 Friday afternoon. The meeting opened with the appointing of the nominating committee, consisting of W. L. Eikenberry, Mabel Smallwood, and M. L. Sawyer.

The first paper of the afternoon was presented by Professor Caldwell, who discussed the present science situation in secondary schools, with especial emphasis on high school agriculture. He called attention to the following definite conditions:

First, While the sciences themselves are very definite, too definite, the science course for the four years is too indefinite and lacks wholly in coordination. In general, the biological sciences are found in the first and second years and the physical sciences in the third and fourth. Still, no one general plan is being followed as any of the usual sciences found in a four year course can be found anywhere in the course, bearing all possible relations to each other.

Second, there is no uniformity as to the amount of science given, some schools giving none, some schools giving five or six different sciences.

Third, there is no uniformity as to the amount of science required, requirements ranging from "all required," through "some required" to "none required."

Fourth, the same chaotic condition is evident in the length of course. The biology course ranges from two months to two years. The chemistry and physics, in general, one year, still show a range in length from one-half year to four years, physics in some of the Eastern schools being given for four years.

This condition can partly be explained by examining the development of high school science. Physics, for example, came into our schools in this country as natural philosophy, grew rapidly and soon developed a body of definitely organized knowledge closely related to life. Then the thread of the organized, unified subject was made prominent and the old method of approach forgotten. Physics as a science was not the viewpoint when the science came in. Natural philosophy was not logical, not clearly organized. It made an appeal because it rationalized the things with which we have to deal from day to day. Physics as a unified, organized science is the physics of the college. A different viewpoint is necessary for the physics of the secondary school.

The other sciences have shared in the history of physics in secondary schools, and like it they need a change in viewpoint. Botany must show how plants meet man's needs—a new viewpoint is necessary, and just here the agricultural phase of the subject comes in. Agriculture has elicited a large interest because it promises to do what botany has failed to do. Agriculture offers a means of practicalizing science. It is more of a protest against our methods of teaching science than it is a new science. In shaping the curriculum of new type of schools they have always started close to the people and as a result have been a benefit to a large number. They then slowly grow more formal, then new needs come in and finally another educational revolution results.

In trying to determine the content of agriculture and its relation to the other sciences five leading text-books were examined with the result that little was found that is not found and taught in botany and zoölogy and other sciences. The following were the books examined, and upon which report was made:

"Agriculture for Schools of the Pacific Slope," Hilgard and Osterhaut.

2. "Principles of Agriculture," Bailey.
3. "Elements of Agriculture for High Schools," Warren.
4. "Agriculture Through the Laboratory and School Garden," Jackson and Dougherty.
5. "Elementary Principles of Agriculture," Fergeson and Lewis.

The above books were examined and analyzed in detail on the basis of the number of pages devoted to each of the following topics:

1. Physics, theoretical and applied.
2. Chemistry, theoretical and applied.
3. Physiography.
4. Botany, elements of, theoretical (as treated in most texts on the subject).
5. Botany, applied.
6. Zoölogy, elements of, theoretical (as treated in most texts on the subject).
7. Zoölogy, applied.
8. Evolutionary Studies. (a) Animals and animal breeding. (b) Plants and plant breeding.
9. Human physiology.
10. Soil, nature and treatment (including physiography of soil origin).
11. Fertilizers, artificial.
12. Farm implements.
13. Household science.
14. Rural sociology.

The first book shows the following pages devoted to the respective topics:

1. Physics—0.
2. Chemistry—0.
3. Physiography—5.
4. Botany, elements of—134.
   Applied—149.
5. Zoölogy, elements of—0.
   Applied—23.
   Human physiology—31.
6. Soil—56.
7. Fertilizers—10.
8. Farm implements—0.
9. Household science—0.
10. Rural sociology—12.

The above shows 283 pages devoted to botany, 8 pages to plant breeding, 56 pages to soils, and 76 out of the 413 left for agriculture, exclusive of the above topics; chief emphasis is on botany and zoölogy.

The second book, "Principles of Agriculture," contains 276 pages, 86 of which are devoted to soils, 51 to physiology, and the remainder to botany and zoölogy topics, several topics being omitted; chief emphasis is on soils and physiology.

"Elements of Agriculture for High Schools," contains 420 pages and devotes 146 pages to botany, 130 to zoölogy, 45 to fertilizers, 28 to rural sociology topics, several topics being omitted; emphasis is on botany and zoölogy.

"Agriculture Through the School Garden," contains 389 pages and devotes 92 to botany, 148 to zoölogy, 103 to soils, 41 to rural sociology several topics being omitted; emphasis is on zoölogy, soils, and botany.

"Elementary Principles of Agriculture," contains 303 pages and devotes 86 to botany, 111 to zoölogy, 48 to soils, 12 to fertilizers, 7 to farm implements, and 22 to rural sociology, several topics being omitted; emphasis is on zoölogy.

The above examination would seem to indicate that agriculture, as a separate science, is not yet organized but is made up from material taken from the other sciences and largely unchanged in its nature. This mate-

rial taken from the other sciences because of the significant method of treatment given to it is what has made agriculture worth while.

The place for a special science of agriculture seems to be not before, but after the other sciences. According to Professor Josiah Main, who has given much study to this question, an ideal arrangement would place the fundamental sciences, taught with the economic aspect, in the first three years and agriculture in the fourth year as follows:

First Year—Elementary physiography, soil tillage, weathering, etc.

Second Year—Botany, horticulture, crops, cereals, etc.

Third Year—Chemistry, invertebrate zoölogy, economic entomology, bacteria, etc.

Fourth Year—Physics, agriculture, animal husbandry, farm equipment, rural economics, crop rotation, animal breeding, etc.

Professor Caldwell's paper called out a general discussion. Mr. Conrad called for suggestions as to tangible solution of the problem—how get hold of something more hopeful?

Professor Caldwell encouragingly said that better courses were being taught than were found in books. The viewpoint of the teacher is the most vital thing. We must tie things up with the materials around us. We must get away from the idea that science must be taught as a science. It is not necessary to touch on every point in an elementary course touched on in a higher course.

Mr. Clute urged an outdoor laboratory where the pupils can "go through the motions" just as in physics or chemistry. He indicated, too, that one can't teach agriculture without an agricultural laboratory, that agriculture can't be taught under present conditions.

Mr. Wright suggested that horticulture was more possible than agriculture, and Mr. Wager indicated that the edge of their athletic field at De Kalb had done good service in demonstrating crop rotation, orchard problems, and successful forage crops.

The discussion was closed by Mr. Whitney, who said that the education of the trustees and those in control was necessary, as the need of an outdoor laboratory is neither appreciated nor understood.

Mr. A. F. Ewers of McKinley high school, St. Louis, next read a paper, "How to Make Botany Interesting to Boys and Girls Reared in a City."

The discussion which followed Mr. Ewers' paper was of a practical nature. The possibilities of work with bulbs was presented. Enthusiastic class work and certainty of results were two of the tangible factors suggested. Coffee as an economic study was also suggested—adulterants, starch test, method of glazing, etc.

The next paper was presented by W. W. Whitney of Bowen high school, Chicago, on "The Application of Zoölogy to the Life of the Pupil and the Community."

In the discussion of this paper Miss Smallwood suggested that few of the high school pupils were going to farm for a living and that the botany course isn't required to make agriculturists, but is required to create a general sympathy and interest in living things. The *Geographic Magazine* was urged as most helpful and suggestive in solving the problem of how to make botany "connect up" with live problems. It is published by the Geographic Society at Washington, price, $2.00.

The last paper of the morning was "A First Year Course in Science," presented by Ada Weckel of Oak Park high school, Oak Park, Ill.

The discussion of the paper indicated that in Oak Park the elementary science course has had a distinct effect on the later sciences. The per cent of those electing one science had increased from 53 per cent in 1908

to 67 per cent in 1911. Mr. Eikenberry, in discussing the first year science course, said that a general view, such as the first year course involves, can't help but be vital and is needed because at present the first year student has no idea of the commonest scientific facts.

Five o'clock and the session adjourned.

The session was next called to order by the chairman at 10 o'clock Saturday morning. The first business was the report of the nominating committee. W. L. Eikenberry, chairman of the committee, submitted the following:

Chairman, Fred W. Warner, Milwaukee.
Vice-Chairman, W. H. Wright, Chicago.
Secretary, J. R. Locke, Streator.

The report was unanimously accepted.

Next came the report of the committee on "The Scientific Study of Biology Teaching:"

REPORT OF THE COMMITTEE OF THE SCIENTIFIC STUDY OF BIOLOGY TEACHING.

One year ago, in continuing this committee for another year the section asked that to its duty of encouraging and coöperating with pedagogical investigations, it should add the farther duty of making available the literature of the subject.

We have sought to fulfill this last requirement by publishing in SCHOOL SCIENCE AND MATHEMATICS a list of titles which might be useful to the student of the subject. In preparing this list it immediately became evident that the best interests of the members of the section would not be served by restricting the list to strictly biological material. In a subject so new as this, the method of attack is often of more importance than the subject-matter and therefore the investigator must be familiar with similar work in other fields than his own. For this reason three classes of titles have been included; general discussions of experimental education, typical investigations in the pedagogy of nonbiological subjects, and investigations in the pedagogy of biology. In the latter two classes it was sought to admit nothing that was not founded upon measurable data and therefore entitled to be called research. The titles were published as they came to hand and are therefore not classified. They are printed in a form which will be convenient for card catalogues, in which form each may classify for himself.

There are indications of interest and activity in the matter of investigation on the part of the members of the section and others, but as yet little work has been carried far enough to allow final results to emerge. The last few years have seen great activity in the investigation of administrative problems and of the fundamental school activities such as reading, writing, and number work, but the high school departments are as yet largely untouched. This is not strange in view of the complicated nature of the problems involved and the almost total lack of an established technique. These difficulties are precisely those of any new line of investigation and will yield to persistent attack.

Your committee recommends, for the following year, that the section place itself in position to coöperate in the suggestions made in general sessions by the committee appointed by the whole Association. Your committee also believes that the time is opportune for this section to take up, as a section, an investigation of some sort within its own field. The problem should be such as to call for the collection and study of data by each member of the section in order that all may have some experience in this type of work. We, therefore, propose that a committee be appointed for

the next year whose duty it shall be to conduct an investigation into the present state of biology teaching in the secondary schools of the territory covered by this Association, or into such other subject as shall seem best to them.

Mr. Eikenberry in presenting the report said that the propaganda stage is now past and time for action arrived. Everything is ready for examination. The curriculum is in a state of fluidity. We should know what we want, why we want it, and what we can do with it.

Mr. Conrad suggested that commercial interests seem to be dictating what shall be done in the schools—dollars vs. men and women the trend. The curriculum should be framed and education guided by educators of high ideals. Mr. Conrad moved and it was seconded and carried that a new committee be appointed to set such definite problems as shall help in the solution of he problem of content for the science course. Mr. Eikenberry was appointed by the chair as chairman of such a committee with instructions to choose the other members of his committee.

The round table discussion followed. One of the first questions discussed was suggested by Mr. Warner, who wished to know whether anyone had really replaced the type study by the topic method. Mr. Whitney replied by saying that he emphasized type *study* rather than type *animal*, using the animal to illustrate a principle. The objection that the type method lacks a suitable text-book was urged. This was met by suggesting that large portions of many of the recent books are easily adjustable to the topic method.

Collections of insects, seeds, shells, and life histories were suggested as material for arousing interest.

The relative amount of time spent on vertebrates and invertebrates was discussed. Twenty-two weeks to invertebrates and sixteen to vertebrates seemed to be the usual time allowed.

The problem of dissection next came up—some indicating dissection of several vertebrate forms as fish, sparrow, rat, and cat. Most thought little dissecting desirable and urged work with the live forms instead. Domestic animals were urged as worthy attention.

Mr. Eikenberry was next asked for a report on his experiments on the development of inference from observation. He reported too much variation in results for the results to be regarded as significant as yet.

Suggestions were next called for by Mr. Eikenberry as to desirable material for scientific investigation. The following suggestions were made:

1. Is the present biological teaching such that the results are evident in later college work?
2. What *is* the actual state of biological teaching? Let ten submit papers and let these be graded by several with a comparison of results.
3. Let *student interest* be determined by offering two sets of questions on a single type, say clam, one formed from scientific viewpoint, and the other from the economic—the student free to choose either.

The above informal discussion closed the Saturday morning session and the meeting adjourned.

FAITH MCAULEY, *Secretary.*

IOWA ASSOCIATION OF MATHEMATICS TEACHERS.

The Iowa Association of Mathematics Teachers held its meeting in Room 25 of the West High School in Des Moines on November 9, 1911, in connection with the State Teachers' Association.

The meeting was called to order at 2:30 P. M. by Professor Ira S. Condit of Cedar Falls, President of the Association. The minutes of the previous meeting and the treasurer's report were read and approved. President Condit stated three subjects for consideration:

1. Time of Meeting.
2. Appointing of committee to investigate work in state.
3. Committee on nominations.

Upon suggestion, before these subjects were taken up, the matter of inviting the Central Association of Mathematics Teachers to hold its annual meeting of 1912 in Des Moines, was discussed. The vote to extend the invitation was passed.

After some discussion, it was decided: 1. To fix the time of meeting upon Thursday of the week of meeting of the Iowa State Teachers Association. 2. To leave the appointing of the committee on investigation of work in the state to the president for the coming year. 3. To appoint Mr. W. Lee Jordan of Des Moines, Miss Hansen of Cedar Falls, and Mr. Ballard of Allerton as committee on nominations.

The Association then proceeded with its program. The Report of the Committee on Abridging and Enriching the Course in Mathematics in Iowa public schools was submitted by Mr. F. M. Hammitt of Ottumwa, chairman of the committee. It was based upon answers received to questions sent out to county and city superintendents, and teachers of mathematics. These questions dealt with quantity, quality, efficiency, and purpose of work done in rural schools, grade schools, grammar schools, and high schools of Iowa.

The report was a clear setting forth of these conditions, and will form an excellent basis for the work of the committee appointed to continue the work during the coming year, and to formulate a plan for correlating the work in mathematics in our high schools.

Superintendent Greenwood of Kansas City gave an address upon "A Sensible Method of Teaching Arithmetic." It was an elaboration of some fundamental principles in the theory and practice of teaching arithmetic, such as: Kinds of number concepts, symbols of numbers, sense of number developed through objects, continuity, two-fold purpose, wise choice of process, no loss of time, wise choice of illustration, constructive drawing to scale, use of oral work, and avoidance of "method" in teaching problems.

A very free discussion of matter presented in this discussion followed, and many helpful suggestions were made.

It was further decided to appoint a committee to report at next meeting recommendations to the State Board concerning the elimination of unpractical subjects from examinations in mathematics.

The nominating committee then made its report, which was adopted as follows:

President, Professor L. F. Neff, Drake University, Des Moines.

Vice-President, Professor C. S. Cory, Iowa State Teachers College, Cedar Falls.

Secretary, Harriet Solomon, Keokuk High School, Keokuk.

Upon motion the meeting adjourned.

HARRIET SOLOMON, *Secretary.*

SOUTHERN CALIFORNIA SCIENCE AND MATHEMATICS ASSOCIATION.

The annual meeting of this association was held at the Polytechnic high school, Los Angeles, Wednesday, December 20, 1911. The general morning session was held in the auditorium, the chief address being given by Dr. J. A. Scherer, president of Throop Polytechnic Institute, on "The Civil Engineer."

Following this the general business meeting was held, when committees presented the results of their work with recommendations. The election of officers resulted as follows: President, G. C. Bush, South Pasadena city schools; Vice-President, H. C. Van Buskirk, Throop Polytechnic Institute, Pasadena, Cal.; Secretary-Treasurer, A. A. Hummel, Los Angeles State Normal School.

After luncheon the science men assembled in Room 242 of the Institute, where the following program was carried out: Address (illustrated)—"The Work of the Venice Marine Biological Station of the University of Southern California," Professor Charles L. Edwards, University of Southern California. Address—"Climatic Variation in California," Professor J. F. Chamberlain, Los Angeles State Normal.

The mathematics folk assembled in Room 212 and listened to the following: Paper—"Computations," Professor H. C. Van Buskirk, Throop Polytechnic Institute. Paper—"The Essentials of Mathematics," Professor E. H. Barker, Los Angeles Polytechnic high school.

After these papers were read these officers were elected for the ensuing year: Chairman, Frank Van Vliet, Long Beach high school, Vice-Chairman, W. W. Keyes, Hollywood high school, Secretary, Miss Amina McNaughton, Pasadena high school.

The entire meeting was excellent and well attended. All who were present were well repaid. C. H. S.

THE ASSOCIATION OF MATHEMATICAL TEACHERS IN NEW ENGLAND.

The ninth annual meeting of this association was held in Huntington Hall, Massachusetts Institute of Technology, on December 9, 1911, at 2 P. M.

The meeting was called to order by the President, Mr. Galbraith, and the first business was the report of the committee on nominations, which was as follows:

The committee appointed to nominate officers for the ensuing year respectfully submits the following report: For president, Archibald V. Galbraith; vice-president, George D. Olds; treasurer, Fred W. Gentleman; councillors (three years), Ernest G. Hapgood, Frederick S. Woods.

It was moved and seconded that the list of officers be declared elected, as offered by the committee. The motion was carried, and the officers were declared elected.

The retiring treasurer, Mr. Morse, read the financial report for the year 1911 as follows:

ANNUAL REPORT OF THE TREASURER.

RECEIPTS.

Cash on hand December 1, 1911	$283.72
Received for dues	149.00
Received for SCHOOL SCIENCE AND MATHEMATICS	48.00
Received from dinner fund	6.50
Received from sale of locus pamphlet	.40
Total	$487.62

EXPENDITURES.

Stamps	$2.00
Printing	50.70
Expenses of secretary	20.45
Rebate to Connecticut Association	4.00
Clerical help	2.40
Dinner fund	7.75
Subscriptions to SCHOOL SCIENCE AND MATHEMATICS	48.00
Expenses of Boston meeting (1910)	19.00
Expenses of Worcester meeting (1911)	10.95
Expenses of Boston meeting (1911)	5.00
Express	.50
Expenses of nominating committee	.50
Total	$171.25
Balance on hand December 1, 1911	$316.37

The report was accepted, and a vote of thanks was extended to the retiring treasurer.

A motion was made and seconded that a standing committee be appointed by the president on recent mathematical literature. The motion was carried.

The secretary read the resolutions of the committee of the American Federation of Teachers of the Mathematical and Natural Sciences, on college entrance requirements in mathematics and science. The matter was laid on the table.

A motion was made and carried that the delegate to the federation be constituted a committee to confer with the committee of the Association of Teachers of Mathematics in the Middle States and Maryland on the question of forming a "general association which should include, or rather absorb existing local associations of mathematical teachers in the East."

At the close of the business meeting, those present listened to two papers; one on "The Conduct of the Class Room Exercise," by Professor George D. Olds, dean of Amherst College, and one on "Le Moine's Géométrographie" by Professor Julian L. Coolidge of Harvard University.

Professor Coolidge gave an account supplemented by blackboard drawings of Le Moine's method of analyzing geometric constructions. By means of this analysis a comparison was made of the labor involved in various constructions of the same problem, and the comparative accuracy of each was also taken into account.

PHYSICS CLUB OF NEW YORK.

The sixty-fourth regular meeting of this club was held in the physics lecture room of Pratt Institute Saturday, December 9.

The early part of the day was devoted to an inspection of the well-equipped laboratories, this was followed by the regular business meeting, after which the following list of papers were read:

"Needs and Limitations of Laboratory Work in Mechanics," Miss Alice H. Bruère, Wadleigh High School.

"How to Make Mechanics Real," Mr. J. M. Jameson, Pratt Institute.

"Real Problems in Accelerated Motion," Mr. Frank B. Spaulding, Boys' High School.

"Teaching of Motion and Energy," Mr. R. H. Cornish, Wadleigh High School.

The New York State Science Teachers' Meeting—"What May Be Done to Improve Our Laboratory Work," Mr. J. A. Randall, Pratt Institute.

"The Quick Comprehension of Machinery," Dr. John F. Woodhull, Teachers College.

"The Physics of Geysers," illustrated, Professor William Hallock, Columbia University.

Luncheon was served at the Institute Club. This was one of the most interesting and helpful meetings which the club has ever held. Not only were the papers valuable, but not the least valuable was the coming together of persons engaged in the same line of work, "brushing" against each other, talking "shop" and getting inspiration from fellow teachers, which is worth while to possess and which cannot be obtained in any other way. C. H. S.

NEW YORK STATE SCIENCE TEACHERS' ASSOCIATION.

The sixteenth annual meeting of the New York State Science Teachers' Association was held at Albany, with the State Teachers' Association at Thanksgiving time. This time was chosen as an experiment, with the hope that the school authorities through the state would be willing to allow the science teachers their time for the two days. In point of attendance, the experiment would hardly be called successful; yet, although the number of teachers from any distance was small, those who were fortunate enough to be present will remember the papers and discussions with pleasure.

Tuesday morning, the general session was called to order by President L. S. Hawkins of the Cortland Normal School. Following a few brief announcements, the various section meetings were held.

Before the teachers of physics and chemistry, H. S. Miner, chief chemist of the Welsbach Light Company, gave an extremely interesting talk on the history, development, and manufacture of gas mantles. Besides an instructive collection of lantern slides, he exhibited a number of gas mantles of slightly different composition, showing that the mantle treated with about one per cent of ceria gives the highest candle power.

Chairman of the section, H. A. Carpenter, spoke briefly about a class in physics for girls. He emphasized the subject of heat and outlined several experiments in radiation, leading to the determination of the best insulating materials for fireless cookers. Some discussion followed, which brought out the fact that the physics teachers are deeply interested in the movement for experiments for the girls different from those for the boys.

In the biology section, the first paper by F. W. Hartwell presented some of the problems in biology which confront the city teachers especially. The idea was repeated several time in the discussion, that the subject should be made a study of living things rather than dead things. Snakes, frogs, turtles, fish, beetles, etc., can be easily kept in the laboratory and constantly furnish material for interest.

G. A. Bailey gave a short talk on the use of the lantern in biology teaching. He emphasized the following uses: To show (a) rare specimens; (b) small fruits and flowers that need to be magnified; (c) different stages in the development of flowers, etc.; (d) to be used in review when specimens cannot be obtained; (e) in taking up a new subject, the different points can be explained to the whole class at one time; (f) to show animals in their natural environment.

The section in agriculture held an enthusiastic meeting, addressed by F. W. Howe and Miss Elizabeth F. Genung.

Tuesday afternoon the Association greatly enjoyed a visit to the immense plant of the General Electric Company at Schenectady.

Wednesday morning a general session was held, addressed by Professor C. P. Steinmetz of Union College on the subject, "School Science and Industry." He showed the relation between the school and community and criticised each for its apparent lack of interest in the other. This was followed by an address by Professor C. F. Hodge of Clark University on the subject, "Civic Biology." He told of the many problems in sanitation, in cleanliness, in ridding a community of pests, such as flies and mosquitoes, etc., that could be better solved through the influence of the schoolroom than elsewhere.

One of the most important matters of business that came before the Association was the report of the committee on the preparation of new experiments in physics. Chairman J. A. Randall of Pratt Institute reported that the committee had prepared several experiments in mechanics and had had the apparatus made by one of the large Eastern apparatus manufacturers and brought to the meeting as an exhibit. These experiments are to be performed with apparatus that is large enough to command the respect of the pupils and are practical applications of some of the important laws of physics, such as the parallelogram of forces as applied to the crane, rpof truss, etc.

The work of the committee has only begun as the entire list of experiments will include all of the main topics of the subject as usually taught. As the work goes on, the committee hopes to be able to publish blue prints of the apparatus so that it can be made by any teacher having a little mechanical skill; and also mimeographed sheets of directions to accompany the apparatus showing its use. These will probably be sent to all members of the Association who are teaching physics. The character of the work of the committee is shown in the type of experiments described in Mr. Jameson's article on page 195 of this JOURNAL.

The committee on chemistry experiments, Chairman Professor J. F. Woodhull of Teachers' College did not report at the meeting, but it was understood that it had not been idle, and under the leadership of the committee on physics would be ready to report at the next meeting. A committee on physics experiments, especially for girls, was voted to work in conjunction with the other two committees. These three committees will be ready to give full and detailed reports at the next meeting of the Association and will form the nucleus of a meeting that ought to be full of interest for all science teachers. The next meeting will probably be held at Syracuse at Christmas time as formerly.

The following officers were elected: President, Ernest Reveley Smith, North High School, Syracuse; Vice-President, Guy A. Bailey, Geneseo Normal School; Secretary-Treasurer, Bryan O. Burgin, Albany High School.

ERNEST R. SMITH.

REPORT OF THE ANNUAL MEETING OF THE AMERICAN FEDERATION OF TEACHERS OF THE MATHEMATICAL AND THE NATURAL SCIENCES.

The American Federation of Teachers of the Mathematical and the Natural Sciences held its annual meeting at the New Willard Hotel in Washington on December 27.

The Associations composing the Federation reported concerning their activities during the past year, and the reports of committees were considered as follows:

Action on the recommendations in the report of the Committee on College Entrance Requirements was postponed for one year, with the understanding that the various associations were to take action on it in the meantime, and were to report their decisions to the Federation.

The National Geometry Committee report was approved as a report of progress. The chairman, Dr. Slaught, reported that a preliminary report would soon be distributed to all members of the Federation who were engaged in mathematics teaching, as well as to such other teachers as were interested. An edition of 5,000 copies will be published, the expense being borne by the National Educational Association.

The amendments reorganizing the Council by limiting the representation of each association to one member were adopted, as follows:

Section 5. Each association shall have one delegate on the Federation Council, this delegate to cast one vote for every fifty members of the association he represents, but to have at least one vote. The delegate may be chosen in any way decided upon by his association, shall hold office for three years, or until the appointment of his successor, and shall be eligible for reëlection. In case of a vacancy by death or resignation, the association in question must at once appoint a successor.

Section 7. The duty of a delegate shall be to keep the secretary of the Federation informed as to the activities of his association, and to represent the interests of his association at every meeting of the Council. If for any reason he cannot attend a meeting, he shall be responsible for being represented by a properly accredited proxy.

The associations have been asked to appoint these representatives at once, and it is hoped that the new Council will soon be in full working order.

The treasurer reports as follows:

Expenditures.		Receipts.	
Stationery and stamps	$ 8.50	Balance from 1910	$ 85.60
Printing and mailing	70.52	Dues from 12 associations	179.20
National Geometry Com.	100.00		$264.80
	$179.02		
Balance	85.78		
	$264.80		

One association—The Association of Biology Teachers of New York—has resigned from the Federation, and two associations with an approximate membership of 150 have not yet paid their dues for the year.

A committee of teachers of physics:

J. A. Randall, Pratt Institute, Brooklyn, Chairman.
W. R. Pyle, Morris High School, New York City.
W. A. Hedrick, McKinley Manual Training School, Washington, D. C.
G. A. Works, Madison, Wis.
P. B. Woodworth, Lewis Institute, Chicago.

has been appointed "to coördinate new apparatus and new teaching content with the present secondary school physics course."

Mr. Randall is chairman of a similar committee of the New York State Science Teachers' Association, and committees to coöperate in this work have already been appointed by the Physics Club of New York and

the New Jersey State Science Teachers' Association. It is hoped that the National Educational Association will decide, at next summer's meeting, to be a partner in this undertaking, as it has been in the work of the National Geometry Committee.

The plan of work for the committee is to have each member act as chairman of a local committee, which shall investigate conditions in its territory, collecting data as to new apparatus and improvements in courses to be submitted to the general committee, and giving to the instrument makers plans for whatever apparatus seems worth while. The general committee will probably form a new definition of the "Physics Unit" to correspond with what they find to be the most improved usage in the subject, and will perfect machinery by which every physics teacher in the country can secure the most improved forms of equipment.

On Thursday morning, at a joint session with Section L of the A. A. A. S., the members of the Council listened to addresses by Professor C. W. Moore of Harvard, Professor A. L. Jones of Columbia, and Dean J. R. Angell of Chicago University on the new systems of admission to these colleges.

EUGENE R. SMITH, *Secretary*,
Polytechnic Preparatory School, Brooklyn.

ARTICLES IN CURRENT PERIODICALS.

American Forestry for January: "The National Aspect of Swamp Drainage," M. O. Leighton, three illustrations; "Some Notes on German Forestry," Warren H. Miller, three illustrations; "Department of Forestry, University of Maine," John M. Briscoe; "The Prairie Dog Must Go," Robert E. Clark, four illustrations; "Irrigation in Turkestan," A. P. Davis, four illustrations; "The Adirondack Problem," Gifford Pinchot.

Catholic Educational Review for January: "The Sisters' College," Thomas Edward Shields; "Education of the Laity in the Middle Ages," Patrick J. McCormick; "School Life and Work in the Immigration Period," James A. Burns; "A Tripartite Aid to Religious Education," Brother Julian; "From Ethical Culture to the Borders of Rome," Patrick Cummins; "Intellectual Qualities of the Religious Educator," Brother Constantius; "The Seminary and Education," Edward A. Pace.

Condor for November-December: "Another Fortnight on the Farallones" (with seven photos), William L. Dawson; "Some Robins' and Mourning Doves' Nests in the Lower Yakima Valley, Washington" (with two illustrations), Clarence H. Kennedy; "Nesting Notes on the Ducks of the Barr Lake Region, Colorado. Part II" (with ten photos), Robert B. Rockwell; "The Relation of Birds to an Insect Outbreak in Northern California during the Spring and Summer of 1911" (with four photos), Harold C. Bryant; "Further Notes from Santa Cruz Island," Alfred B. Howell and A. van Rossem.

Educational Psychology for January: "The Class Experiment in Psychology with Advertisements as Materials," Robert M. Yerkes; "Mental Fatigue in Day School Children as Measured by Immediate Memory. Part I," W. H. Winch; "Problems in the Experimental Pedagogy of Elementary Agriculture," Garland A. Bricker.

Education for January: "Recent Changes in the Rules of the New England College Entrance Certificate Board," Frank W. Nicolson; "Reasons for Modifying Entrance Requirements," Charles H. Judd; "Plan for College Admission Proposed by the National Education Association," Clarence D. Kingsley; "Culture, the Ideal of the College," Francis G. Allinson; "The College Curriculum as a Preparation for Vocation." Clarence F. Birdseye.

Photo-Era for January: "The Eighth American Photographic Salon," Helen J. Niles; "Notes on the Use of Actinometer-Exposure-Meters," Malcolm D. Miller, M.D.; "The Autochrome in Winter," Alfred H. Lewis; "Helping Defective Shadows," James Thomson; "Photography in Winter," Rupert Bridge; "Judging Exposures by the Eye," Photography.

Physical Review for December: "The Optical Constants of Alloys as a Function of Composition," J. T. Littleton, Jr.; "The Acoustic Shadow of a Rigid Sphere, with Certain Applications in Architectural Acoustics and Audition," G. W. Stewart; "Artificial Rotatory Polarization," Arthur W. Ewell; "The Measurement of the Frictional Force Exerted on a Sphere by a Viscous Fluid, when the Center of the Sphere Performs small Periodic Oscillations along a Straight Line," George F. McEwen; "Entladungsstrahlen at Atmospheric Pressure and at Diminished Pressures," Elizabeth R. Laird; "Note on Electrically Produced Water Ripples," Frederic Palmer, Jr.; "The Thermoelectric Behavior of Heusler Alloys in a Magnetic Field," L. O. Grondahl and S. Karrer; "Certain Characteristics of Light-Negative Selenium," Lilah B. Crum; "Refractive Index of Metals," P. A. Ross.

Popular Science Monthly for January: "The Mechanistic Conception of Life," Dr. Jacques Loeb; "Science among the Chinese," Dr. C. K. Edmunds; "Notes on Norwegian Industry," James Lewis Howe; "The Duties to the Public of Research Institutes in Pure Science," William E. Ritter; "Small Colleges," John J. Stevenson; "The Problem of City Milk Supplies," Dr. P. G. Heineman; "Collecting on a Coral Reef," Vernon L. Kellogg; "The Origin and Control of Mental Defectiveness," Dr. Chas. B. Davenport; "The Paris Academy of Sciences," Dr. Edward F. Williams.

Psychological Clinic for December: "The Binet-Simon Scale for Measuring Intelligence; Impressions Gained by Its Application," Lewis M. Terman, Ph.D., Stanford University, California; "A Study of the Binet Definition Tests," Isabel Lawrence, State Normal School, St. Cloud, Minn.; "A Practical Guide for the Administration of the Binet-Simon Scale for Measuring Intelligence," J. E. Wallace Wallin, Ph.D., Stanton, Iowa.

School World for January: "Teachers' Views of Examiners' Reports on Local Examinations: IV. Geography," A. H. Harries, B.A.; "V. Mathematics. (1) General Principles," R. Wyke Bayliss; "VI. Modern Languages," Walter Rippmann; "Secondary Education in London;" "Teachers' Reference Libraries;" "Salaries in English Secondary Schools;" "The Teaching of Elementary Formal Geometry," William P. Milne; "Oxford University Local Examinations. Set Subjects for 1913;" "The Position and Value of School Examinations."

Scientific American for December 23: "Sir Joseph John Thomson," P. Phillips; "Artificial Silk—A Textile Marvel," H. W. Ambruster; "Destruction of the 'Maine' by a Low-Explosive Mine and Her Own Magazines," illustrated.

Scientific American Supplement for December 23: "The Psychology of Light," R. S. Woodworth; "The Sewer System of Havana," C. C. Scherer.

Zeitschrift für den Physikalischen und Chemischen Unterricht for November: "Ueber wichtigere Resonanz-Erscheinungen und deren experimentelle Vorführung," R. Hartman Kempf; "Mefseinrichtung für Gleich- und Wechselströme," H. Rudolph; "Thermoelektrische Versuche," J. Weib; "Uber die Pole gerader Drahtmagneten," Fr. C. G. Müller; "Chemische Versuche mit einer neuen Form von Probiergläsern," O. Ohmann. Kleine Mitteilungen: "Die Stellung der Mondsichel zum Horizont," H. Meyer; "Ein Experiment über den Luftdruck," H. J. Oosting; "Zum Archimedischen Prinzipe," E. Grünfeld; "Die Messung der Zug- und Druckkomponente auf der schiefen Ebene," K. Krüse; "H. Rudolph, Schwingungen an einer Einfadenglühlampe—W. Wolkmann, Kleine Verbesserungen an Schieberwiderständen," Für die Praxis. Berichte: I. Apparate und Versuche: "Zur Demonstration der Gesetze der Wellenfortpflazung,"

G. Rossi; "Ein Modell zur Erläuterung der Relativitätstheorie," E. Cohn.

Zeitschrift für Mathematischen und Naturwissenschaftlichen Unterricht for December: "Ueber die Verschmelzung verschiedener Zweige des mathematischen Unterrichts," Rudolf Schimmack; "Eine einfache Lösung und Ableitung der Lösung der kubischen Gleichung," Prof. Milarch; "Der Ellipsenreif," Dr. Otto Richter; "Zur Geometrographie, Auflösungen, Aufgaben."

Unterrichtsblätter für Mathematik und Naturwissenschaften, No. 8: "In welcher Beziehung kann der biologische Unterricht fördernd auf die gesamte Geistesbildung der Schüler wirken?" Prof. Dr. Höck; "Ueber Ortsgedächtnis bei Fischen und seine Bedeutung für Wanderungen der Fische," Dr. V. Franz; "Die Behandlung des Taylorschen Satzes in der Schule," G. Lony.

BOOKS RECEIVED.

Microscopy and the Microscopical Examination of Drugs. By Charles E. Gabel. 117 pages. 14x21 cm. Cloth. 1912. The Kenyon Company, Des Moines, Ia.

Annual Report of the Smithsonian Institution for year ending June 30, 1910. 688 pages. 15x24 cm. Cloth. Government Printing Office.

The Iliad of Homer. Edited by Charles E. Rhodes, Lafayette High School, Buffalo. Pp. xxix+642. 11x15 cm. Cloth. 1911. 25 cents, net. The Macmillan Company, New York.

Plant Life and Evolution. By Douglas H. Campbell, Leland Stanford University. 360—iv pages. 13x19 cm. Cloth. 1911. $1.60 net. Henry Holt and Company, New York.

Transactions of the Illinois Academy of Science. 172 pages. 16x24 cm. Paper. 1911. Published by the State.

BOOK REVIEWS.

The Evolution of Plants, by D. H. Scott. Pp. 256. 12½x18 cm. 1911. Henry Holt & Co., New York.

This book is an account of the evolution of the higher plants based almost wholly on the fossil evidences. Paleobotany has been almost completely neglected by the schools with the result that very little is known about it either among high school teachers or students of botany. The little that has been done came largely from the laboratories of the geologists. Naturally, the state of knowledge regarding fossil plants left much to be desired from the botanical standpoint. It is only within a comparatively few years that the study of the morphology of the fossil plants has been placed upon a plane where comparison with studies of existing forms is possible. We are now in possession of even the details of cell structure in the most delicate parts of many fossil plants, and this knowledge regarding actual steps in past evolution is a decided corrective to our theories of descent.

Scott is himself an authority in this field and has in the present book attempted to bring this new knowledge to the average botanist and the lay reader. He has succeeded admirably. It may be imagined that the man who is not a botanist and not familiar with the morphology of recent seed-plants might not find the book particularly inviting, but anyone who has mastered the amount of morphology represented by any good high

school text in botany will be able to read the book with profit and interest. The high school teacher ought to be familiar with just such knowledge as is here set forth, not for purposes of instruction to pupils, but to give him better perspective and background.

An interesting argument, admittedly without positive evidence in the fossil record, is that which seeks to show a possible derivation of the Pteridophytes from the Algae direct, the Byrophytes being wholly eliminated from the main line of descent. The moss sporophyte is considered to be merely a fructification.

It is not likely that the ecologists will agree with the author's assignment of causes for evolutionary changes. For instance, it is not wholly clear that the reduction of the gametophyte generation in ferns took place because "the land plant had to make the most of its land-phase and to economize on the less adaptable, water bound prothallus." Similar illustrations of the interpretation of structure as a response to the necessities of the plant abound. W. L. E.

New Manual of Botany of the Central Rocky Mountains, by John M. Coulter, revised by Aven Nelson. 8vo., pp. 646. Cloth $2.50. Flexible leather, $3.00. American Book Co.

The recent appearance of this important manual upon thin paper and in flexible leather, forming a volume 5x7½ inches and scarcely an inch thick, may be the excuse for a rather belated notice of an important addition to botanical literature. All scientists studying the vegetation included within the area covered by the manual, namely, the Rocky Mountain region from Montana and southern Idaho to New Mexico and northern Arizona together with a few isolated localities like the Black Hills of South Dakota, will welcome the revision of Coulter's well-known work upon the flora of this region. The book has been not only revised but entirely rewritten and rearranged. It is now up to date in following the Englar sequence of families and the nomenclature of the Vienna congress, and in the use of the metric system of measurements, but at the same time conservative in its treatment of new genera and species. An improved analytical key of the usual type is supplemented by numerous additional subordinate keys for the species of the larger genera, making it easier to determine the identity of any plant. While this feature will recommend it to the amateur, the specialist will be pleased to find included the place and date of publication of each species and a very comprehensive list of synonyms, and yet so concisely has the descriptive work been done that 2,733 different species are included within the compact volume. The field worker will find the new tourist edition an ideal book for a pocket companion. It differs from the style of the new Gray's Manual principally in having no illustrations, but shows the same care in printing and binding, making it a decided acquisition for the further development of a botanical region in which there has been much advance of knowledge during the decades since the manual appeared in its original form. GEO. D. F.

An Illustrated Guide to the Flowering Plants of the Middle Atlantic and New England States, by George T. Stevens. 749 Pp. 14x22 cm. 1911. Dodd, Mead & Co.

This book reminds one in both subject matter and general make-up of Gray's Lessons and Manual. The first fifty-four pages are taken up by a discussion of "structural botany," dealing with the names of the parts of flowering plants and the terminology commonly used in describing such plants. Some 650 pages are occupied by the flora with its keys. The nomenclature and arrangement seem to agree with the seventh edition of Gray's Manual.

The descriptions strike one as being rather less specific in many cases than might be desired; yet until one has had opportunity to try it out well in the field it would be rash to express an opinion regarding either the descriptions or the artificial keys. The unique feature among the less extensive manuals is the matter of illustrations, of which there are some 1,800. No attempt is made to illustrate every species but both in the keys and in connection with the descriptions, line drawings are added wherever they seem needed. While some of these, due to small size or poor reproduction, scarcely represent the point indicated, yet the idea is a good one. Young pupils and people untrained in botany are much helped by just such aids.

The book does not intend to compete with Gray's Manual. It is intended for popular use only and will doubtless have considerable popularity within the region covered on account of greater ease of use. However, no one whose purposes are at all serious will be deterred by the slight difficulties of the other manuals.

Grasses and sedges are not included. The volume is bulky—about 5 cm. in thickness—and neither binding nor press work are particularly pleasing. W. L. E.

Experimental Physics, by C. H. Smith, W. E. Tower, and C. M. Turton. Pp. xxv+324. 13x19 cm. Cloth, 75 cents. 1911. Ginn & Co., Boston.

To provide an up-to-date manual of experiments that accords with the present point of view regarding laboratory work in physics is the aim of this new manual. It is in reality a new manual although it appears as a revision of the "Manual of Experimental Physics," by Nichols, Smith, and Turton. The book has been almost entirely rewritten and the new book contains a large number of new experiments.

Throughout the book references are made to the following texts: Adams, Carhart and Chute, Crew and Jones, Gorton, Linebarger, Millikan and Gale, and Mann and Twiss. The manual is well adapted for use with any of these texts.

A special feature of the book and one in which it excels all other manuals is its wealth of material. It would require at least a year and a half, possibly two years, for a class to work all the experiments. This is intentional on the part of the authors. The teacher, having so large a list to choose from, can select the experiments that are adapted to the needs of his class and to his equipment. If he continues the work for a third semester, as is done in the Chicago high schools, he can continue to use the same manual. But the wealth of material consists not alone in the number of experiments. I know of no other manual that contains so complete a list of tables of reference. There are eighty-eight of these tables.

I have found in two months' use of this manual that the instructions for performing the experiments are clear and explicit and readily understood by the pupil. I find the questions at the end of each experiment to be of special value, requiring the pupil to apply in a practical way the principle learned in the experiment.

Practical applications are emphasized throughout the book and a number of experiments of a purely practical character are included, such as testing the power of a motor.

The requirements of the College Entrance Examination Board have been kept in mind by the authors and the book contains all the material needed to meet these requirements.

The book is sufficiently accurate in its methods to satisfy the most exacting teacher and sufficient emphasis is placed on applications of principles to satisfy the most ardent supporters of the "new movement."

E. E. B.

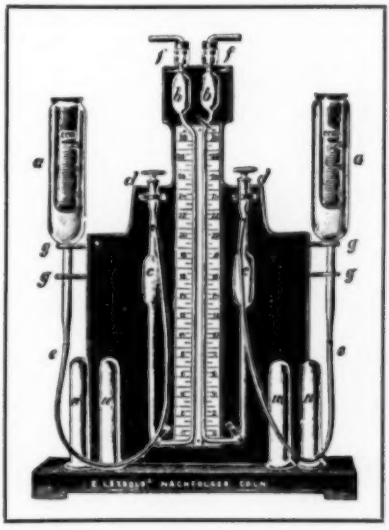
E. Leybold's Nachfolger

COLOGNE (GERMANY)

SCIENTIFIC INSTRUMENT MAKERS

Grand Prize of World's Exhibition, Brussels, 1910, and Turin, 1911, High Honors.

INSTRUMENTS OF PRECISION. ALL KINDS OF PHYSICAL APPARATUS



Looser's and Kolbe's Thermoscopes with all Accessories

Dr. Gaede's High Vacuum Pumps

Vacuum 0,00001 mm Hg.

Universal Rotary Air Pumps

Vacuum 0,01 mm Hg.

Vacuum Gauges, Etc.

Delivery free New York or Baltimore. Guarantee of delivery in working condition. Discharge of all formalities at the Customs. English Catalogue with Prices in $ sent on application.

The Teaching of High School Mathematics by George W. Evans, Headmaster of Charlestown High School. Pp. x+94. 12x18 cm. 1911. Price 35 cents. Houghton, Mifflin Company, Boston.

The success of efforts to improve the subject-matter and the methods of mathematics teaching depends upon the teacher. He must understand the reasons for the present widespread attempt to make mathematics of greater value and efficiency in preparing pupils for his work in life in order to make him a better worker and a better citizen. This book will help the teacher to a clearer view of the situation, and offers many helpful suggestions in regard to the use of material and method.

The titles of the chapters are as follows:

The Modern Point of View; The Order of Topics; Equations and their Uses; Some Rules of Thumb; Geometry as Algebraic Material; The Graphical Method; The Bases of Proof in Geometry; The Method of Limits; Simpson's Rule and the Curve of Sections; The Teacher.

When the Graph began to appear in high school mathematics some ten years ago, it was used almost entirely to represent equations. But so many more important uses have been found for graphical methods that it seems far better to introduce graphs early in first-year algebra and let the pupils gain a knowledge of them by using them in representing tables of values and in solving problems.

The chapter on Computations with Numbers obtained by measurement is of especial importance for high-school pupils. H. E. C.

Agricultural Instruction in the Public High Schools of the United States, by Clarence Hall Robison. Pp. viii+205. 15½x22½ cm., 1911, Teachers College, New York.

A study of the present status of agricultural instruction in the field indicated. The only broad study of the facts of the situation which has yet been published, and at the present time the principal source of information on this live question. Its scope is best indicated by the chapter titles which are as follows:

I. Agricultural Education.
II. The Public High School.
III. Some Typical High Schools Teaching Agriculture.
IV. Administration, Equipment and Methods.
V. Preparation and Salaries of Teachers of Agriculture in the High Schools.
VI. Special Secondary Schools of Agriculture.
VII. Problems of Agricultural Instruction in the Secondary School.

These chapters are occupied almost wholly by presentation of the results of extended investigations made by the author. The data secured are expressed in very definite form and when possible are tabulated so that it is easy for the reader to get at the facts. The author's opinions and prejudices are very carefully eliminated. The facts are presented as found and the reader is left to draw his own conclusion.

Dr. Robison does not argue either for or against the development of agricultural instruction of secondary grade and has no pet methods of instruction or types of courses to suggest. The literature of the subject is already burdened with elaborate but untried schemes for reorganizing the whole system of education on an agricultural basis and it is a relief to find a presentation of the matter from which one can learn just what is actually being accomplished and the direction of the strongest tendencies.

Agricultural education, as a protest against the formalism of high school science, is of interest to every science teacher. In many cases the agri-

Bergen and Caldwell's

Practical Botany

Price $1.30

THE NEWEST BOOK AMONG THE
WELL-KNOWN BERGEN BOTANIES

PRACTICAL BOTANY was published in September, 1911, and admirably fills the great demand for a practical botany which shall give a short and adequate course for pupils who wish to present botany for college entrance, or for those who desire a good working knowledge of the science without going into advanced study. The book is suited to either a year's or half-year's course. Plant Study has been made especially significant to the pupil by relating it closely to his everyday interests. Much material that is valuable on industrial, agricultural and horticultural subjects is included.

GINN AND COMPANY, PUBLISHERS

BOSTON NEW YORK CHICAGO LONDON
ATLANTA DALLAS COLUMBUS SAN FRANCISCO

The Stone-Millis Mathematics Series

Stone-Millis Grade Arithmetics	Stone-Millis Algebras
Stone-Millis Secondary Arithmetic	Stone-Millis Geometries

A complete series for grades and high school, unique in extent and unique in principle. There is no other series of books in the subject of Mathematics that runs through the grades and high school, all written by the same authors. There is no other series so thoroughly practical and sane. Let the pupil solve real problems that might conceivably arise in the lives of real people, and not problems that are mere puzzles because the answers to them were known before the problems were made. Let there be a natural use for the work—this is the unique principle. Such real problem material is used in these books as a concrete setting to theoretical work as sound as ever was written.

By PROFESSOR JOHN C. STONE,
State Normal School, Upper Montclair, New Jersey,
and
PROF. JAMES F. MILLIS,
Francis W. Parker School, Chicago, Illinois.

WRITE US FOR INFORMATION

BENJ. H. SANBORN & COMPANY

BOSTON NEW YORK CHICAGO

Please mention School Science and Mathematics when answering advertisements.

culture as taught at present is in fact but another kind of botany which appears to the people to be more vital. "There can be no doubt that this spreading tendency noticeable in small high schools is a protest against the formalism into which botany, in common with physics, has fallen. The botanists have only themselves to blame for the widespread substitution of a body of knowledge, poorly digested as yet, for a wholesome and scholarly kind of science work, because the influence of these leaders has been so largely for the 'pure science' botany and so little for the kind that touches the life of the pupil and the interests of the community." To the teacher who wishes to measure this new competitor, or better yet, to the one who wishes to improve his own work in accordance with the real needs of the times, this book is invaluable.

The value of the book is greatly enhanced by the addition of a summary of legislation on agricultural education, a bibliography of the late literature, and a good index. W. L. E.

Brief Course in Analytic Geometry, by J. H. Tanner, Cornell University, and Joseph Allen, College of the City of New York. Pp. x+306. 12x 18 cm. 1911. American Book Company.

By omitting details of little importance the authors present a course in analytic geometry which can be covered satisfactorily in twelve weeks. It affords an excellent preparation for work in practical calculus, and at the same time gives the training desirable for the general student.

The chapter on the locus and the equation presents clearly the fundamental problems of analytic geometry; and as in the other chapters the large number of numerical problems gives the student the opportunity of really understanding the principles and methods of this branch of mathematics.

The authors do well to hold to the older methods of deriving the equations of the conic sections, but there are many excellent reasons for the use of the methods of calculus in finding the equations of tangents. The chapters on solid analytic geometry in a brief treatment give all that is necessary for use in finding surfaces and volumes in calculus.

H. E. C.

Beginnings in Agriculture, by Albert Russell Mann, Cornell University. Pp. 341, figures 178. Published by the Macmillan Company. 1911. 75 cents, net.

This is one of the few text-books in agriculture that is designed especially for use in the grades. It is intended for use in the seventh and eighth grades, though the possibility of its use in small high schools is suggested. The content of the book is founded primarily upon the "Report of the Committee on Industrial Education in Schools and Rural Communities," a committee which reported to the National Educational Association. The author further states that he has tried to "cover the work very largely in a nature study spirit, by which is meant that the pupil shall be brought into as close touch as possible with actual farms, soils, crops, animals, and affairs."

The book deals with the affairs of agriculture, the soil, farm crops and farm animals, with several chapters given to each topic. The detail topics are essentially the same as those presented in the majority of agricultural text-books, and therefore need not be repeated in a review. Distinctive features of the book are found in the method of presentation. It is simple in style, in the main with brief staccato sentences, with a vocabulary that is much more simple than that usually found in such books. New topics are approached in a way that should stimulate pupils to want to find out about them. Chapters close with lists of practical problems that should make the work seem quite real to the pupils.

EIMER & AMEND

HEADQUARTERS

FOR

Chemicals, Chemical Apparatus, Minerals, etc.

WE CARRY THE LARGEST STOCK OF LABORATORY SUPPLIES IN THE U. S.

First Quality Supplies Only. Prompt Service.

Our European connections are such that we are enabled to offer you the best service for duty free importations on scientific supplies at the lowest rates.

Analytical Balances and Weights

ONE OF OUR LEADING SPECIALTIES

EST'B - 1851
203 - 211 - THIRD - AVE
NEW-YORK-CITY

The Wm. Gaertner Co., Chicago

THE GAERTNER HIGH SCHOOL GALVANOMETER

This instrument is a new and greatly improved form of the inexpensive galvanometer originally designed for the Millikan & Gale Course. The improved instrument is easily equivalent in sensitiveness, convenience and durability; in fact, in all the essential characteristics of a good galvanometer, to any $4.00, $6.00 or even $10.00 instrument of its kind now in the market.

The Improvements consist in:

1. The Suspension—made both above and below of phosphor bronze as in high grade instruments, thus dispensing with all loose wires and making it possible to place the binding posts in a convenient position.
2. The Closed Top—making a dust-proof case.
3. The Torsion Head—adjustable up and down so that the coil may be locked and the instrument easily and safely transported.
4. The Lever on the Torsion Head—making possible an accurate and convenient zero setting.
5. The Soft Iron Core—giving a much stronger field and a greatly increased sensitiveness.
6. The Inclined Scale—increasing greatly the convenience of reading, either for a single individual or for a class.
7. The Leveling Screws—greatly increasing the convenience of centering.

Price $2.50

The idea that certain structures are given to plants in order that certain functions may be performed—a purpose for everything—is all too prevalent. For example, "The burdock and stick-tight are given little coiled arms to clutch the fur or hair of a passing animal and ride away to a new home." "The tumbleweed excels many others in cleverness." "The touch-me-not provides itself with a spring which * * * throws the seeds far away from the parent." Also mooted questions are ignored regarding the nature of the plant food in the soil, and this may be proper in a strictly elementary presentation. O. W. C.

Introductory Algebra, by John H. Walsh, Associate Superintendent of Schools, the City of New York. Pp. ix+214. 13x19 cm. 1911. D. C. Heath & Co.

To quote the entire preface would give an adequate review of this book, and would set forth in plain and convincing terms the reasons for studying algebra, and the reasons for studying the kind of algebra presented by the author.

The emphasis on equations throughout, the large number of simple sight and written exercises, the omission of complicated forms and expressions, the maximum of practice with the minimum of theory, all tend to give the greatest practical value of the study of algebra to the pupils who do not continue their mathematical studies.

If this statement of a recent writer is true: "A pupil who is confronted in his first year of high school with Latin, ancient history, and algebra has a grievance against our civilization," then quite a portion of one third of this grievance would be eliminated by the use of this text-book. It is unfortunate that the book makes no use of graphical methods.

H. E. C.

A Text-Book of Physics, by Louis B. Spinney, Iowa State College. xi+605. 15x22 cm. Cloth. 1911. $2.75, net. The Macmillan Company, New York.

This is a splendid book written primarily for use in schools where technical courses are offered. From this viewpoint the author has laid particular stress on the practical aspect of the subject. Familiar phenomena are made use of in illustrating important physical laws. The topic of mechanics is discussed to considerable length from its fundamental importance in giving to the student a clearer understanding of the entire subject of physics. Since the book is to be used as a basis for class room work and supplemented by lectures and laboratory work, many descriptions and illustrations have for this reason been omitted. To understand the book thoroughly the student must have a good working knowledge of algebra, geometry, and trigonometry. All illustrations are, however, made as simple as possible. The subject-matter is treated in the old conventional order, mechanics coming first followed in order by heat, electricity, and magnetism, sound and light. Nearly every one of the forty-seven chapters closes with an excellent list of practical problems. Practically all of the 384 splendid cuts are made from original drawings, this gives the book a tone distinctively its own. It is written in a magnificent style, clear, understandable, and to the point, where especial emphasis is to be brought out the word or sentence is printed in **bold face** type, a better plan than *italicized* type, a very complete index is given. An inspection of the book shows that it has been written by a master of the subject. Mechanically the book represents the highest type of workmanship.

C. H. S.

ORDERING

SPENCER MICROSCOPES

You have opportunity of selecting from the largest, most comprehensive and complete line of microscopes made by any manufacturer.

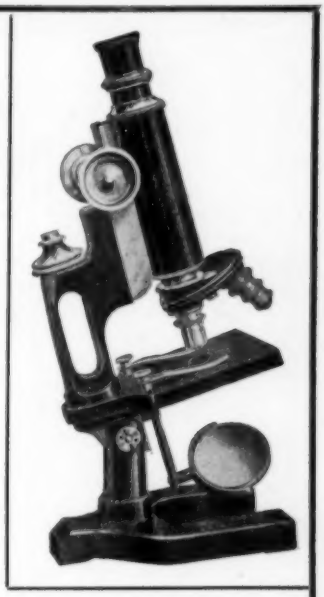
18 DISTINCT TYPES

THEY EXCEL IN

I. OPTICAL SUPERIORITY.
II. MECHANICAL PERFECTION.
III. EMBODIMENT OF IMPROVEMENTS and features of practical usability, features which make for convenience and comfort in use and which mark them as best adapted to their purpose.

Catalog sent on request

SPENCER LENS CO.,
BUFFALO, N. Y.



No. 66B Microscope
16 mm. and 4 mm. objectives, double nose piece, one eyepiece, iris diaphragm, complete in cabinet, - - **$31.50**

DISCOUNT TO SCHOOLS

THE

School World

A Monthly Magazine of Educational Work and Progress

Price 6d monthly Yearly Volumes 7/6 Net each

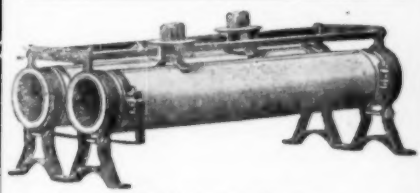
THE aim of "The School World" is to provide teachers with information of practical and permanent value. To this end all important changes and developments affecting any branch of education are dealt with by leading educational authorities and experienced teachers.

¶ Each issue contains Eighty Columns of Reading Matter.

¶ The magazine is indispensable to all educational workers who desire to keep in touch with modern methods of education.

LONDON
MACMILLAN AND CO., Limited
NEW YORK: THE MACMILLAN COMPANY

LABORATORY RHEOSTATS



"G-R" Laboratory Rheostat

Every school laboratory requires rheostats. Are you properly equipped in this line?

"G-R" RHEOSTATS

are specially designed for laboratory use. They are made in a great many sizes and are inexpensive. We have supplied them for a number of years with great satisfaction. Let us know your needs and we will submit an interesting offer. We can also supply carbon compression rheostats, and all forms of resistance boxes, the inexpensive kind as well as precision apparatus.

Write for illustrated Bulletin 720 of G-R Rheostats

JAMES G. BIDDLE
Electrical and Scientific Instruments
1211-13 Arch St. - PHILADELPHIA

SCIENCE AND MATHEMATICS SOCIETIES.

Under this heading are published in the February, June, and October issues of this journal the name and officers of such societies as furnish us this information. We ask members to keep us informed as to any change in the officiary of their society. Names are dropped when they become a year old.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

President, Dr. Edward C. Pickering, director of the Harvard Astronomical Observatory; *Vice-Presidents,* Section A—E. B. Van Vleck, University of Wisconsin; Section B—Arthur Gordon Webster, Clark University; Section C—W. Lash Miller, Toronto; Section D—J. A. Holmes, Washington, D. C.; Section E—James E. Todd, University of Kansas; Section F—William A. Locy, Northwestern University; Section G—D. S. Johnson, Johns Hopkins University; Section H—J. Walter Fewkes, Washington, D. C.; Section I—John Hays Hammond, New York; Section K—J. J. McCleod, Cleveland, Ohio; Section L—J. McKeen Cattell, Columbia University; *Secretaries of Sections*: Section B—W. J. Humphreys, Mount Weather, Va.; Section E—Geo. F. Kay, University of Iowa; Section K—Waldemar Koch, Chicago University; *General Secretary,* H. E. Summers, Iowa State College; *Secretary of the Council,* H. W. Springsteen, Western Reserve University.

AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS.

President, W. D. Hunter, Dallas, Texas; *Vice-Presidents,* T. J. Headlee, Manhattan, Kan.; R. A. Cooley, Bozeman, Mont.; *Secretary,* A. F. Burgess, Melrose Highlands, Mass.

AMERICAN FEDERATION OF TEACHERS OF THE MATHEMATICAL AND NATURAL SCIENCES.

Executive Committee: Chairman, C. R. Mann, University of Chicago; *Secretary,* Eugene R. Smith, Polytechnic Preparatory School, Brooklyn; Ira M. De Long, Boulder, Colorado; Wilhelm Segerblom, Phillips Exeter Academy, Exter, N. H.; I. N. Mitchell, State Normal School, Milwaukee.

AMERICAN MATHEMATICAL SOCIETY.

President, Professor H. B. Fine, Princeton University; *Vice-Presidents,* H. F. Blichfeldt and Henry Taber; *Secretary,* F. N. Cole; *Treasurer,* J. H. Tanner; *Librarian,* D. E. Smith; *Committee of Publication,* F. N. Cole, E. W. Brown and Virgil Snyder.

AMERICAN NATURE-STUDY SOCIETY.

President, B. M. Davis, Miami University, Oxford, O.; *Vice-Presidents,* Stanley Coulter, F. L. Stevens, Gilbert H. Trafton, and F. L. Holtz.

AMERICAN PALEONTOLOGICAL SOCIETY.

President, David White, Washington, D. C.; *Vice-President,* J. C. Merriam, Berkeley, Cal.; *Secretary,* R. S. Bassler, Washington, D. C.; *Treasurer,* Richard S. Lull, New Haven, Conn.; *Editor,* Charles R. Eastman, Cambridge, Mass.

AMERICAN PHYSIOLOGICAL SOCIETY.

President, S. J. Meltzer, New York; *Secretary,* A. J. Carlson, Chicago; *Treasurer,* W. B. Cannon, Boston; *Members of the Council,* J. Erlanger, St. Louis, and F. S. Lee, New York.

AMERICAN SOCIETY OF BIOCHEMISTS.

President, Dr. Archibald B. Macallum, University of Toronto; *Secretary,* Dr. A. N. Richards, University of Pennsylvania; *Treasurer,* Dr. Walter Jones, Johns Hopkins University; *Councilors,* Drs. L. B. Mendel, Yale, and H. Gideon Wells, University of Chicago.

AMERICAN SOCIETY OF NATURALISTS.

President, Professor E. G. Conklin, Princeton University; *Vice-President,* Professor R. G. Harrison, Yale University; *Secretary,* Professor A. L. Treadwell, Vassar College; *Treasurer,* Professor W. E. Kellicott, Goucher College.

ASSOCIATION OF OHIO TEACHERS OF MATHEMATICS AND SCIENCE.

President, William P. Holt, Central High School, Toledo; *Vice-President,* Ralph W. Buck, Stivers Manual Training School, Dayton; *Secretary-Treasurer,* Miss Harriet E. Glazier, Western College for Women, Oxford; *Assistant Secretary,* R. O. Austin, School of Commerce, Columbus.

Successful Text Books

Young and Jackson's Algebras
Gorton's High School Course in Physics

ARE YOU FAMILIAR WITH THESE BOOKS?
CORRESPONDENCE FROM TEACHERS INVITED

PUBLISHED BY

D. APPLETON AND COMPANY

New York ═══ Chicago

TEACHERS COLLEGE MATHEMATICAL PUBLICATIONS

TEACHING OF ARITHMETIC
By Professor David Eugene Smith, LL. D.
Reprint of Vol. x, No. 1, of the Teachers College Record, January, 1909. 120 pages. Price, cloth bound, 75 cents; paper bound, 30 cents.

ARITHMETICAL ABILITIES AND SOME FACTORS DETERMINING THEM
By Cliff Winfield Stone, Ph. D.
Published as No. 19 of the Teachers College Contributions to Education, June, 1908. Cloth bound, 101 pages. Price, $1.00 postpaid.

A HISTORY OF SIXTEENTH CENTURY ARITHMETIC
By Lambert L. Jackson, Ph. D.
Published as No. 8 of the Teachers College Contributions to Education, 1906. Cloth bound, 261 pages. Price, $2.00 postpaid.

HISTORY OF TEACHING OF ELEMENTARY GEOMETRY
By Alva Walker Stamper, Ph. D.
Published as No. 23 of the Teachers College Contributions to Education, 1909. Cloth bound, 163 pages. Price, $1.50 postpaid. Paper, $1.15.

Address all orders and requests for circulars to

Bureau of Publications
Teachers College, - - Columbia University
525 West 120th Street - - - New York City

ASSOCIATION OF MATHEMATICS IN NEW ENGLAND.

President, Archibald V. Galbraith; *Vice-President,* George D. Olds; *Treasurer,* Fred W. Gentleman; *Councillors,* Ernest G. Hapgood, Frederick S. Woods.

ASSOCIATION OF TEACHERS OF MATHEMATICS FOR THE MIDDLE STATES AND MARYLAND.

President, I. J. Schwatt, University of Pennsylvania; *Vice-President,* A. E. King, Erasmus Hall High School, Brooklyn; *Secretary,* H. F. Hart, Montclair High School, Montclair, N. J.; *Treasurer,* Susan C. Lodge, Philadelphia Collegiate Institute, Philadelphia.

BOTANICAL SOCIETY OF AMERICA.

President, L. R. Jones, University of Wisconsin; *Vice-President,* B. M. Duggar, Cornell University; *Secretary,* G. T. Moore, Washington University; *Councilor,* Wm. Trelease, Missouri Botanical Garden.

CENTRAL ASSOCIATION OF SCIENCE AND MATHEMATICS TEACHERS.

Executive Committee—*President,* Herbert E. Cobb, Lewis Institute, Chicago, Ill.; *Secretary-Treasurer,* C. E. Spicer, Joliet Township High School, 100 Sherman Street, Joliet, Ill.; *Assistant Secretary-Treasurer,* F. C. Donecker, Crane Technical High School, Chicago, Ill.; Biology—*Chairman,* Fred W. Werner, North Division High School, Milwaukee, Wis.; *Vice-Chairman,* W. H. Wright, McKinley High School, Chicago, Ill.; *Secretary,* J. R. Locke, Streator Township High School, Streator, Ill.; Chemistry—*Chairman,* J. W. Shepherd, Chicago Teachers College, Chicago, Ill.; *Vice-Chairman,* Chester B. Curtis, Central High School, St. Louis, Mo.; *Secretary,* Leon D. Judd, Lockport Township High School, Lockport, Ill.; Earth Science—*Chairman,* G. R. Mansfield, Northwestern University, Evanston, Ill.; *Vice-Chairman,* W. E. Durstine, Technical High School, Cleveland, Ohio; *Secretary,* Bertha Henderson, State Normal School, Whitewater, Wis.; Mathematics—*Chairman,* Ira S. Condit, Iowa State Teachers College, Cedar Falls, Ia.; *Vice-Chairman* Chas. W. Newhall, Shattuck School, Faribault, Minn.; *Secretary,* E. Marie Gugle, Central High School, Toledo, Ohio; Physics—*Chairman,* E. E. Burns, Medill High School, Chicago, Ill.; *Vice-Chairman,* William M. Butler, Yeatman High School, St. Louis, Mo.; *Secretary,* E. P. Reynolds, State Normal School, Platteville, Wis.

COLORADO MATHEMATICS ASSOCIATION.

President, Saul Epsteen, University of Colorado, Boulder; *Secretary-Treasurer,* Grace E. Shoe, North Side High School, Denver.

EASTERN ASSOCIATION OF PHYSICS TEACHERS.

President, C. S. Griswold, Groton School, Groton, Mass.; *Vice-President,* Fred H. Cowan, Girls' Latin School, Boston, Mass.; *Secretary,* Alfred M. Butler, High School, East Boston, Mass.; *Treasurer,* Percy S. Brayton, Medford High School, Medford, Mass.

GEOLOGICAL SOCIETY OF AMERICA.

President, Herman L. Fairchild, Rochester University; *Vice-Presidents,* I. C. White and David White; *Secretary,* Edmund O. Hovey; *Treasurer,* William B. Clark; *Editor,* Joseph Stanley-Brown; *Librarian,* H. P. Cushing.

ILLINOIS STATE ACADEMY OF SCIENCE.

President, W. A. Noyes, Illinois State University, Urbana, Ill.; *Vice-President,* J. C. Udden, Augustana College, Rock Island, Ill.; *Secretary,* Frank C. Baker, The Chicago Academy of Sciences, Chicago; *Treasurer,* J. C. Hessler, James Millikin University, Decatur, Ill.

INDIANA ACADEMY OF SCIENCE.

President, Charles R. Dryer, State Normal School; *Vice-President,* David W. Dennis, Earlham College; *Secretary,* Andrew J. Bigney, Moores Hill College; *Assistant Secretary,* E. A. Williamson; *Press Secretary,* Milo H. Stuart, Indianapolis Manual Training School; *Treasurer,* W. J. Moenhaus, State University; *Editor,* L. J. Rettger, State Normal School.

INDIANA ASSOCIATION OF SCIENCE AND MATHEMATICS.

President, C. A. Vallance, Indianapolis; *Vice-President,* Roy Cummins, Fort Wayne; *Secretary-Treasurer,* Henry F. A. Meier, Evansville.

Has your School a WEBSTER'S NEW INTERNATIONAL DICTIONARY - THE MERRIAM WEBSTER?

WEBSTER'S NEW INTERNATIONAL DICTIONARY
THE LATEST AUTHENTIC EDITION OF THE MERRIAM SERIES
WEBSTER'S NEW INTERNATIONAL DICTIONARY
G&C MERRIAM CO.

CONSIDER how much accurate information your scholars will gain by having readily accessible this "*Library in a Single Volume.*" It is a **NEW CREATION** containing in concise form just those facts that you so often seek. It answers with final authority all kinds of questions in Language, History, Fiction, Geography, Biography, Mythology, Etc. You will be surprised to know that the type matter is equivalent to a 15 volume encyclopedia.

400,000 WORDS DEFINED. 2700 PAGES. 6000 ILLUSTRATIONS. A striking feature is the new divided page,—a "*Stroke of Genius.*"

WHY not at once make a requisition for the New International — The Merriam Webster?

Direct that your scholars *use* constantly the new book to answer their numerous questions. The result will save much of your time and also stimulate the *dictionary habit.*

WRITE for specimen pages, illustrations, etc. Mention this publication and receive **FREE** a set of pocket maps.

G. & C. MERRIAM COMPANY,
Springfield, Mass.

Columbia University
IN THE CITY OF NEW YORK

Summer Session, July 8-August 17, 1912

TEACHERS COLLEGE WILL OFFER 150 COURSES

by its regular staff, including:

History of Education, Paul Monroe, W. H. Kilpatrick; Philosophy of Education, Henry Suzzallo, E. N. Henderson; Educational Administration, George D. Strayer, Frederick E. Farrington, Superintendent A. W. Edson; Educational Psychology, Edward L. Thorndike, Henry Ruger, Stevenson Smith, John B. Watson; Secondary Education, Frederick E. Farrington, Romiett Stevens; Elementary Education, F. M. McMurry, Milo B. Hillegas, Henry C. Pearson, Principal J. F. Reigart; Rural Education, Frederick G. Bonser and special lecturers; Kindergarten Education, Patty S. Hill, Grace Fulmer; The Teaching of Elementary English, F. T. Baker; Fine Arts, A. W. Dow; The Teaching of Geography, C. B. Kirchwey; The Teaching of German, E. W. Bagster-Collins; The Teaching of Latin, W. H. D. Rouse, Cambridge, England; The Teaching of Mathematics, W. E. Breckenridge; The Teaching of Physical Science, R. H. Williams; The Teaching of Domestic Art and Domestic Science in Elementary Schools, Mrs. Gilchrist-Strong; The Teaching of Industrial Arts in Elementary and Secondary Schools, Frederick G. Bonser.

Courses will also be offered in Biology, Music, Nature Study, Physical Education, Nutrition and Food Economics, Foods and Cookery, Household and Physiological Chemistry, Textiles and Clothing, Design for the Household and Industrial Arts, Household Administration, Nursing and Health, Mechanical Drawing, Machine Design and Construction, Industrial Mathematics, Woodworking, Metal-working, Ceramics, Photography, and the History of Industry.

Detailed information will be sent upon request.

University of Wisconsin

SUMMER SESSION, 1912

JUNE 24 TO AUGUST 2
(LAW, JUNE 24 TO AUGUST 30)

250 courses in Graduate School, Law School, Colleges of Letters and Science, Engineering, and Agriculture. Special graduate courses in Mathematics and Physics: Mechanics, Aerodynamics, Gyroscopic Motion, Modern Theory of Physical Phenomena, Electricity and Magnetism.

For illustrated bulletin, address

Registrar, University, Madison, Wis.

SUMMER COURSES
FOR TEACHERS
THE UNIVERSITY OF CHICAGO
THE SCHOOL OF EDUCATION

Courses for elementary school teachers
Courses for secondary school teachers
Courses for superintendents and supervisors
Courses for normal school teachers
Courses for college teachers of education

Some of these courses are advanced courses leading to graduate degrees; some are elementary courses leading to certificates or bachelor's degrees. General courses in Education (History, Administration, Educ. Psychology and Methods). Special courses in History, Home Economics, Mathematics, Geography, School Science, School Library, Kindergarten, Manual Training, and the Arts. Registration in the School of Education admits to University courses in all departments. First term 1912, June 17, to July 24; second term July 25 to August 30. Circular on request.

THE UNIVERSITY OF CHICAGO
Chicago, Illinois

IOWA ASSOCIATION OF MATHEMATICS TEACHERS.

President, L. F. Neff, Drake University, Des Moines; *Vice-President*, C. S. Cory, State Teachers College, Cedar Falls; *Secretary*, Harriet Solomon, Keokuk High School.

KANSAS ASSOCIATION OF MATHEMATICS TEACHERS.

President, W. H. Andrews, State Agricultural College, Manhattan; *Vice-President*, Fiske Allen, State Normal, Emporia; *Secretary-Treasurer*, Eleanora Harris, High School, Hutchinson.

MATHEMATICAL AND PHYSICAL SECTION OF THE ONTARIO EDUCATIONAL ASSOCIATION.

Hon. President, J. A. Houston, Education Department, Toronto; *President*, W. J. Patterson, Western University, London; *Vice-President*, R. Wightman, Hartford Coll. Inst., Toronto; *Secretary-Treasurer*, A. M. Overholt, Coll. Inst., London; *Councillors*, W. L. Sprung, A. M. Robertson, G. W. Keith, W. W. Rutherford, T. Kennedy.

MISSOURI SOCIETY OF TEACHERS OF MATHEMATICS AND SCIENCE.

President, J. S. Stokes, Kirksville; *Secretary and Treasurer*, L. D. Ames, Columbia; *Mathematics Division*—Vice-President, Charles Ammerman, St. Louis; Secretary, E. L. Harrington, Breckenridge; *Science Division*—Vice-president, W. C. Curtis, Columbia; Secretary, Noble L. Garrison, Paris; *Executive Council*—Charles Ammerman, B. C. Brous, W. M. Butler, H. C. Drayer, B. F. Finkel, E. L. Harrington, H. C. Harvey, A. H. Huntington, S. E. Kelsey, George H. Melcher, F. N. Peters, J. H. Scarborough, John W. Scott, B. M. Stigall, J. W. Withers, Miss Anna Pile; E. R. Hedrick, Chairman.

NATIONAL EDUCATION ASSOCIATION.

President, Carroll G. Pearse, Superintendent of Schools, Milwaukee, Wis.; *Secretary*, Irwin Shepard, Winona, Minn.; *Treasurer*, Katherine D. Blake, New York, N. Y.; *Vice-Presidents*, Ella Flagg Young, Chicago, Ill.; George H. Carpenter, Brownwood, Tex.; Charles F. Philbrook, Bisbee, Ariz.; Helen Marsh Wixson, Denver, Colo.; Samuel Andrews, Pittsburgh, Pa.; R. H. Wilson, Oklahoma City, Okla.; S. S. Stockwell, Cheyenne, Wyo.; Edwin D. Ressler, Corvallis, Ore.; Woodland C. Phillips, Maryland; Edward Hyatt, Sacramento, Cal.; Vaughan MacCaughey, Honolulu; *Board of Trustees*, James Y. Joyner, Raleigh, N. C.; James M. Greenwood, Chairman, Kansas City, Mo.; J. Stanley Brown, Joliet, Ill.; Robert J. Aley, Secretary, Orono, Me.; Carroll G. Pearse, Milwaukee, Wis.

NATURAL SCIENCE SECTION OF THE ONTARIO EDUCATIONAL ASSOCIATION.

Hon. President, Professor A. P. Coleman, Toronto University; *President*, A. P. Gundry, Strathroy; *Vice-President*, W. J. Hamilton, Fort William; *Secretary-Treasurer*, F. J. Johnston. 292 Evelyn Ave., Toronto.

NEW ENGLAND ASSOCIATION OF CHEMISTRY TEACHERS.

President, Frederick C. Adams, Mechanic Arts High School, Boston, Mass.; *Vice-President*, Charles W. Goodrich, High School, Waltham, Mass.; *Secretary*, Edward S. Bryant, Everett High School, Everett, Mass.; *Treasurer*, Alfred M. Butler. East Boston High School, East Boston, Mass.

NEW YORK STATE SCIENCE TEACHERS' ASSOCIATION.

President, Ernest Reveley Smith, North High School, Syracuse; *Vice-President*, Guy A. Bailey, State Normal School, Geneseo; *Secretary-Treasurer*, Bryan O. Burgin, High School, Albany; *Council*: 1912, J. S. Shearer, Cornell University, Ithaca; F. L. Bryant, Erasmus Hall High School, Brooklyn; O. C. Kenyon, Central High School, Syracuse. 1913, W. M. Smallwood, Syracuse University; W. M. Bennett, West High School, Rochester; F. P. Huested, High School, Albany. 1914, A. G. Clement, Education Dept., Albany; W. D. Merrell, University of Rochester; J. E. Whitsit, De Witt Clinton High School, New York City. 1915, J. R. Kelton, High School, Amsterdam; H. A. Carpenter, West High School, Rochester; J. A. Randall, Pratt Institute, Brooklyn.

NORTH DAKOTA ASSOCIATION OF SCIENCE AND MATHEMATICS TEACHERS.

President, Principal W. C. Stebbins, High School, Grand Forks; *Vice-President*, E. G. Burch, State Science School, Wahpeton; *Secretary*, L. B. McMullen, State Normal School, Valley City; *Retiring President*, E. F. Chandler.

NORTHEASTERN OHIO ASSOCIATION OF SCIENCE AND MATHEMATICS TEACHERS.

President, H. W. Kennedy, High School, Lakewood; *Vice-President*, R. A. Brown, Shaw High School, E. Cleveland; *Secretary-Treasurer*, H. T. McMyler, High School of Commerce, Cleveland; *Executive Committee*, A. F. M. Petersilge, *Chairman*, East High School, Cleveland; T. C. Woodward, High School, Akron; W. E. Durstine, Technical High School, Cleveland; L. B. Altaffer, West High School, Cleveland; C. S. Kelser, High School, Lorain.

MAX KOHL A. G. CHEMNITZ, GERMANY

FULLY PAID-UP CAPITAL, M 1600 000.

Centrifugal Machine, with double transmission and regulating rheostat, with continuous current electromotor for 30-1100 revolutions per minute.

Physical Apparatus

INDUCTION COILS

Oil Air Pumps

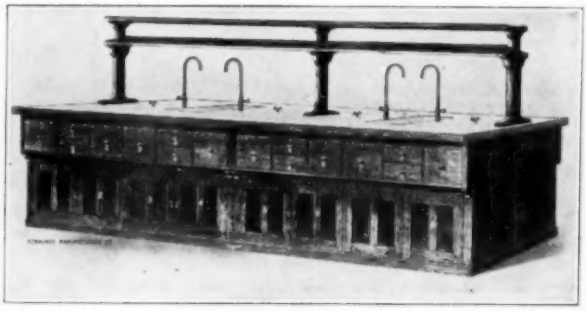
Switchboards for School Laboratories

Projection Apparatus

COMPLETE OUTFITS

for Laboratories of the very best make

World's Fair, Brussel, 1910; 3 Grand Prizes, 1 Gold Medal



Chemistry Table No. 8703

"Kewaunee" Gas Cocks are made of brass, heavily nickel plated. The spout is 2½ inches long, tapered from ¼ inch at the small end to ⅝ inch at the valve. It is designed with 12 serrations making it easy to slip on ¼ inch to ⅜ inch, or ½ inch rubber tubing, but impossible to pull the tubing off accidentally. If you contemplate changing your gas cocks on your equipment we will send sample free. Sold by all leading apparatus and school furniture dealers.

We manufacture a complete line of Laboratory Furniture especially adapted to Scientific Instruction in Chemistry, Biology, Physics and Physiography. Write for our 1911 "Furniture" catalogue.

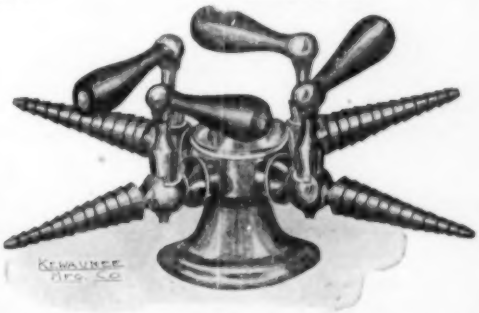
KEWAUNEE MANUFACTURING CO.

MANUFACTURERS OF

High Grade Furniture

KEWAUNEE, -:- WISCONSIN

New York Office, 59 Fifth Ave.



4 Way Gas Turret

NORTHWESTERN OHIO CENTER OF THE CENTRAL ASSOCIATION OF SCIENCE AND MATHEMATICS TEACHERS.

President, C. M. Bronson; *Vice-President,* Miss Marie Gugle, *Secretary-Treasurer,* M. R. Van Cleve, all of the Toledo Central High School; *Executive Committee,* Miss Schneider, W. P. Holt, A. W. Stuart, Toledo Central High School, Miss Strempfer, Toledo East High School and I. F. Mattison, Delphas.

PHYSICS CLUB OF NEW YORK.

President, Raymond B. Brownlee, Stuyvesant High School; *Secretary,* F. W. Huntington, Erasmus Hall High School.

SOUTHERN CALIFORNIA SCIENCE AND MATHEMATICS ASSOCIATION.

President, G. C. Bush, South Pasadena City Schools; *Vice-President,* H. C. Van Buskirk, Throop Polytechnic Institute, Pasadena; *Secretary-Treasurer,* A. A. Hummel, Los Angeles State Normal School.

Mathematics Section—*Chairman,* Frank Van Vliet, Long Beach High School; *Secretary,* Miss Amina McNaughton, Pasadena High School.

SOCIETY OF AMERICAN BACTERIOLOGISTS.

President, Dr. William H. Park, director of the Research Laboratories, City of New York; *Vice-President,* Professor C. E. A. Winslow, College of the City of New York; *Secretary-Treasurer,* Dr. Charles E. Marshall. Michigan Agricultural College, East Lansing.

WISCONSIN ASSOCIATION OF MATHEMATICS TEACHERS.

President, Henry Ericson, Milwaukee; *Vice-President,* Mary C. Nye, Superior; *Secretary-Treasurer,* Professor W. W. Hart, Madison; *Chairman Executive Committee,* J. V. Collins, Stevens Point.

THE NATIONAL GEOMETRY SYLLABUS.

BY H. E. SLAUGHT, *Chairman.*

The provisional report of the National Committee of Fifteen on Geometry Syllabus, which was published in April, May, and June in SCHOOL SCIENCE AND MATHEMATICS, was presented to the Mathematics Section of the National Education Association at San Francisco in July, 1911.

The report was favorably received and discussed with interest and the commitee was authorized to make further modifications in the light of suggestions and criticisms from all sources and then to publish and distribute a large edition among teachers of mathematics in all parts of the country. For this purpose an appropriation was granted. The report was also presented to the Council of the American Federation of Teachers of the Mathematical and Natural Sciences at its meeting in Baltimore in 1911. The report was prepared under the joint auspices of the two bodies. The Federation also provided an appropriation toward the expenses of distributing the report, in recognition of which all mathematics members of the associations forming the Federation will be the first to receive copies of the new edition of the report.

During the autumn and winter the members of the committee have carefully considered all criticisms which have been presented and have made revisions in various parts of the report, in particular adding a section of suggestions to examining bodies on the use of the syllabus. The report, as thus amended, is still issued as a provisional report. Since the committee felt that it should have a wide circulation in this form in order that teachers all over the country might have a chance to study and pass judgment upon it. It is hoped that this report may be made the basis of discussions in meetings of the various associations throughout the year. as has already been done in several instances.

The general distribution of the report will be made through the Bureau of Education at Washington and it is desired that this announcement may be made as widely as possible through educational journals, at educational meetings and by personal activity on the part of all interested. Anyone desiring a copy may secure it gratis upon application to the COMMISSIONER OF EDUCATION, DEPARTMENT OF THE INTERIOR, WASHINGTON, D. C.